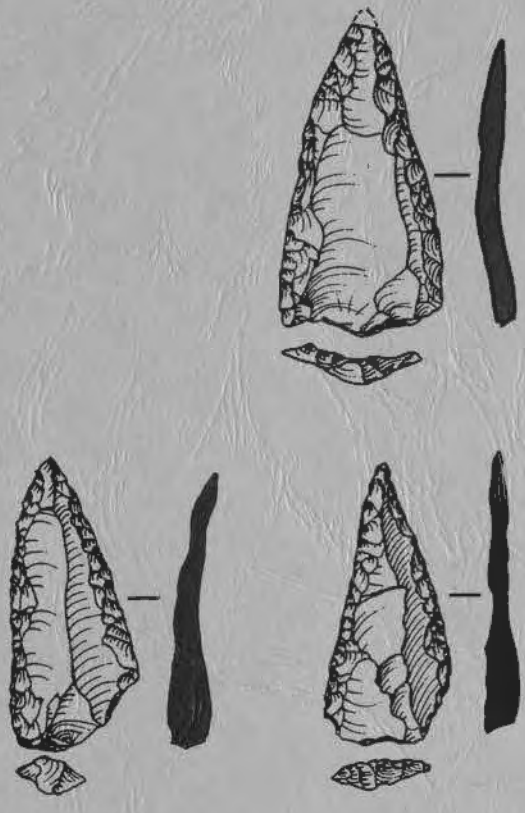
THE MOUSTERIAN OF THE ZAGROS: A REGIONAL PERSPECTIVE

JOHN M. LINDLY



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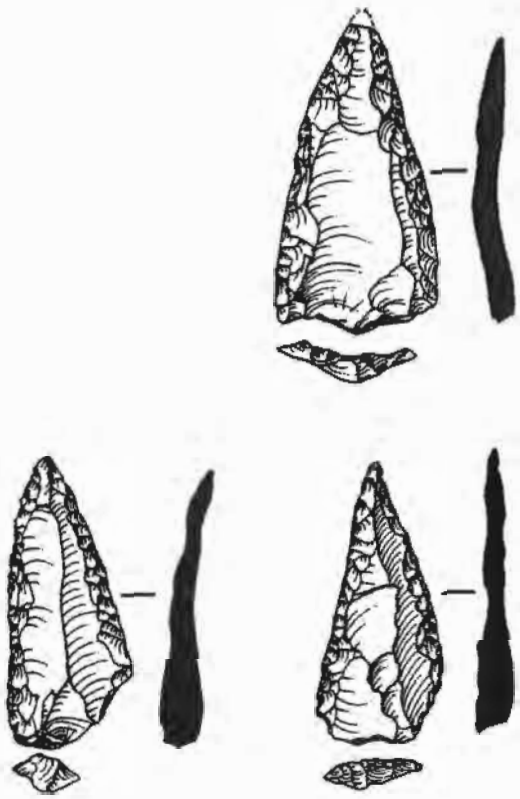

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About the Author . . .

A third-generation Arizonan, John M. Lindly has lived in the greater Phoenix area for most of his life. He has always been interested in history and archaeology, exploring the backcountry of Arizona in his high school and college years. He was awarded all three of his degrees from Arizona State University, receiving the Ph.D in 1997. As an archaeologist, Lindly has worked in Arizona, Guatemala, Jordan, France, and Portugal on sites ranging from historic houses and Hohokam villages to paleolithic caves and rockshelters. The author of more than 25 articles, chapters, and reviews in national and international publications, Dr. Lindly has also taught at Arizona State University and Glendale Community College. He is currently Senior Project Manager and Principal Investigator for SWCA Environmental Consultants in Phoenix, and the co-director of the Paleolithic and Mesolithic Project of Algarve, in Portugal. In his spare time he collects and maintains Triumph automobiles, old Japanese toy tin cars, and antique firearms of the Old West. He is married (to an obviously very understanding woman) and has two terrific children.

The logo for *Anthropological Research Paper No. 56* shows some heavily-retouched Mousterian points (or convergent sidescrapers) from John Speth's 1969 excavations at Kunji Cave, in Luristan (from Baumler & Speth 1993: 65, used with permission). The Kunji lithics have all of the characteristics of Skinner's (1965) 'Zagros Mousterian.'

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The Mousterian of the Zagros: A Regional Perspective

John M. Lindly

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June-el Piper (Anthropological Consulting & Editing) copyedited the entire manuscript, no doubt to its considerable improvement. She also tracked down the numerous permissions required to publish the artifact illustrations that appear here. Donna Carpio (Carpgraphics) produced the original map of the Zagros region that appears here as Figure 1. Michelle Fiedler, formerly of the Department of Anthropology at Arizona State University, undertook the Herculean task of tracking down and verifying the references.

Last, but most certainly not least, deserving of my heartfelt gratitude, are Donna, Lauren, and Alex, who not only put up with me during the writing of this manuscript but have been and continue to be very supportive of everything I did and do to this day. Without them this publication would not have been possible.

1

Introduction

If you ask me, forget about the stone tools. They can tell you nothing, zero. At most they can say something about how they were preparing food. But is what you do in the kitchen all of your life?

—Ofer Bar-Yosef, quoted in Shreeve 1995:193

The Zagros Mousterian is one of the preeminent regions and periods in Old World prehistory. Any introductory textbook will have a section on this area primarily because the "first flower people" lived here and buried their dead with care and ceremony at Shanidar Cave (Solecki 1971). The Neanderthal fossil remains and the purported evidence for ritual behavior have made the Zagros Mousterian notable in any discussion of the Paleolithic (Klein 1989:333; Olszewski and Dibble, eds. 1993; Thomas 1979:360; Wolpoff 1980:264).

Yet, the study of the Zagros Mousterian has taken a back seat in recent years to the more high profile studies taking place in the Levantine region of Southwest Asia. This change of fortune is due primarily to two factors: first, the advent of new techniques for dating stone and bone that have dated the appearance of supposed anatomically modern humans in the Levant to over 100,000 years ago; and second, to the unstable political and social climate of the territory encompassed by what is called the Zagros region, which has effectively prevented any recent excavations and surveys. No early modern human remains have been found associated with Mousterian industries, no new earlier dates, and therefore no fanfare.

Be that as it may, the Zagros Mousterian remains very important to our understanding of the Middle Paleolithic of Southwest Asia and indeed the rest of the Old World. The area itself is at the crossroads between the Levant (and therefore Africa), Europe, and Asia. McBurney (1970) among others hypothesized that the origins of the Upper Paleolithic (and modern man) would be found here. In addition, what we call the Zagros Mousterian exists as a high-altitude adaptation of archaic *Homo sapiens* during much colder environmental conditions, providing insights into a lifeway that was different and more challenging than those in numerous other areas of the world.

This study is a step toward understanding another adaptation by archaic *Homo sapiens* and contributing to an ever-broadening wealth of evidence demonstrating why these hominids survived for at least 100,000 years.

As the quote at the beginning of this chapter suggests, different ways to chip stone tools do not necessarily translate into different ways to make a living. However, as more and more general patterns of stone working become available, we should be able to put together a picture of how these hominids solved problems of adaptation that can be compared to solutions made by anatomically modern humans. It will only be through these sorts of studies that questions of modern human origins and modern human behavior can be resolved.

The study of chipped stone assemblages to generate ideas and answer questions about adaptation has been neglected in recent years. Yet, technology, its organization and implementation, the logistics of applying it to problems in day-to-day living are making a comeback as a legitimate and profitable avenue of study (Kuhn 1995; Nelson 1991). The Bar Yosef quotation is correct in one sense in that stone tools, individually, can be relatively uninformative. However, the analysis of variation in use of raw material, as well as manufacture, use, curation, and discard processes can be the key to understanding much more than "what goes on in the kitchen." This study is an attempt to provide insights into the behavior of Middle Paleolithic hominids by recognizing patterns in stone tool technology. Stone tools are not kitchen-specific and need not be equated to modern knives and forks or even a Swiss army knife because these things are not crucial to the daily survival of modern-day humans (Barton 1990). For Paleolithic peoples chipped stone was frequently the key to life itself. The manufacture of these objects was a means to survival and, therefore, can inform us about this survival in a distinct way.

This research is an exercise in pattern recognition. It is only a first step toward the goal of understanding what was happening during the Middle Paleolithic of the Zagros region. The Zagros Mousterian is described and known from the stone tool assemblages found there. These assemblages have been characterized by a lack of Levallois technique and the presence of narrow, heavily

retouched points (Garrod 1962:247), or by elongated points, few Upper Paleolithic types, no Levallois technique, and no bifaces (Skinner 1965). This view has changed somewhat in recent years with the discovery of more examples of Levallois technique than had previously been realized (Dibble 1984b; Smith 1986). This volume marks the first attempt since Skinner's (1965) to examine a large number of Zagros sites using a uniform analytical approach. The present study of collections from seven sites incorporates a broader, regional perspective and provides a detailed view of this important period of the Paleolithic of Southwest Asia than possible from the study of any single site in isolation.

The following chapter provides a historical perspective of archaeological research in the Zagros. Archaeologists have only become interested in this area again recently, after research effectively stopped there in the 1970s. Thus, there are few large excavations and surveys to examine.

Chapters 3 and 4 discuss the environment and chronology as we know them in this area. The environment of the Zagros is important for an understanding of the season and duration of occupation of these sites, which in turn placed limits on technology and the extraction of resources from the area. The chronology of the area has not been well established owing to the lack of applicable dating techniques during the 1940s to 1960s, when most research was carried out. Thermoluminescence (TL) and Electron Spin Resonance (ESR) dating techniques have yet to be applied to Zagros data. However, the chronology of surrounding regions can be utilized to make limited inferences regarding the Zagros region.

High-altitude adaptations of both modern humans and animals are discussed in Chapter 5 to provide a behavioral baseline for comparing the possible patterns of mobility during the Zagros Middle Paleolithic.

Chapter 6 presents a theoretical background for studying lithic technology from the Paleolithic. An overall technological perspective on stone tools is a relatively new one. Typological studies have tended to dominate Middle Paleolithic chipped stone analysis with a minor nod toward technology, especially in Europe (however, see Bordes 1961a, 1961b, 1972). In contrast, the Middle Paleolithic stone tool analyses in the Levant have been more technological in character (Bar-Yosef and Meignen 1992; Crew 1975; Jelinek 1982; Lindly and Clark 1987; Munday 1977).

The methodology of the analysis is discussed in Chapter 7. The techniques have been borrowed primarily from studies in the Levant, where technology has been emphasized over typology. However, in this study typology is not completely ignored and provides useful insights as well.

Chapter 8 contains the descriptions of the sites considered in this study. Collections from seven sites housed at universities and museums in the United States were utilized. A few of these sites have not been analyzed previously.

The results of the analysis are presented in Chapter 9, and Chapter 10 is a comparison of the results of this study with data from the Levant. A discussion and the conclusions are advanced in Chapter 11.

2

History of Research

The area that we call the Zagros is located in the countries of Iran, Iraq, and in eastern Turkey. It extends 1,600 km from Azerbaijan in the northwest to the Persian Gulf. Interest in the Paleolithic of the Zagros region of Southwest Asia is a relatively recent phenomenon. Smith (1986) has argued that the sociopolitical climate during the early part of this century effectively stifled research. Therefore, the history of research in the region is notably brief. Sites that are analyzed in this volume are indicated in the text and located on Figure 1.

Prior to 1940

Limited reconnoitering of the region began at the end of the nineteenth century with the surveys of Jacques de Morgan and continued in the 1920s and 1930s by Henry Field (Smith 1986). Field reported surface "flint stone implements of Middle and Upper Paleolithic types" on motor trips through Iraq from 1925 to 1928, in 1934, and in 1950. Isolated surface finds were also reported by military and oil company personnel in the 1920s and 1930s (Solecki 1955).

Garrod (1930) was the first to carry out excavations in the area: she dug at Paleolithic sites at Hazar Merd and Zarzi in Iraq in 1928. Hazar Merd was the first Middle Paleolithic site to be excavated in the Zagros and, as such, the artifacts from this site became the "touchstone" for all subsequent excavations in the region.

Hazar Merd

Hazar Merd was excavated from November 20 to December 6, 1928. The cave is located 6 km southwest of Sulaimani near the village of Hazar Merd. The site, which consists of six caves, lies on a ridge of limestone facing northeast at an elevation of 1,200 m above sea level (asl). There is a bench 120 m below the site, and this location apparently has a very good view of the entire valley of Sulaimani below. Garrod concentrated her excavations on "The Dark Cave" (Ashkot-i-Tarik), labeled cave number 3 as viewed north to south. This was because it appeared to contain undisturbed Paleolithic deposits. Only one of the other caves had Paleolithic deposits, but they had been largely eroded out at some time in the past.

The Dark Cave measured 30 m long and approximately 11–12 m in width and 5 m high at the mouth, leading to a higher vault inside. The excavation revealed the following: a top layer down to 1-2 m below the surface composed of reddish earth and containing Bronze Age to recent material; an Upper Paleolithic level, 1–2 cm thick, containing "Aurignacian type" artifacts; and a lower level (C), 50 cm to 3.90 m thick, composed of a "tough reddish earth" containing numerous hearths, animal bones, and relatively few lithic artifacts. Many of these artifacts were burned and associated with the hearths (Garrod 1930:28). Lithic artifacts, found scattered thinly throughout the level, were not very common, with only 254 retouched tools (Figure 2). Faunal remains were rare and apparently highly broken up so that many were unidentifiable. However, Bate identified goat, gazelle, and deer remains (Garrod 1930:38). The lithic artifacts are described as being from a "single Mousterian industry," consisting of a greater number of retouched artifacts than flakes and *no cores*. The plain flakes are described as being triangular or narrow and parallel-sided. Garrod calls this last group "blades." Two handaxes were recovered from the bottom of layer C. Garrod argued there was an affinity between the industry at Hazar Merd and those from Zuttiyeh and Shukba in the Levant because of the presence of blades and "narrow implements," gravers, and flat retouch in both industries. This suggestion of similarity between the Zagros and the Levant was not unexpected given the fact that no other Zagros Mousterian sites had been excavated and that Garrod's previous experience was with Middle Paleolithic sites in the Levant (Garrod and Bate 1937).

Garrod suggested that the Hazar Merd cave was occupied sporadically during a colder period than the present. Because the lithics and bones were burned, suggesting the use of fire, and because artifacts were located in sheltered parts of the cave rather than at the cave mouth, Garrod concluded the environment must have been cold. It is of interest that Garrod (1930:40) appeared to assume that the cave could have been occupied year-round.

After World War II

Paleolithic excavations became more common in the Zagros after World War II as the region was opened up to foreign exploration and investment.

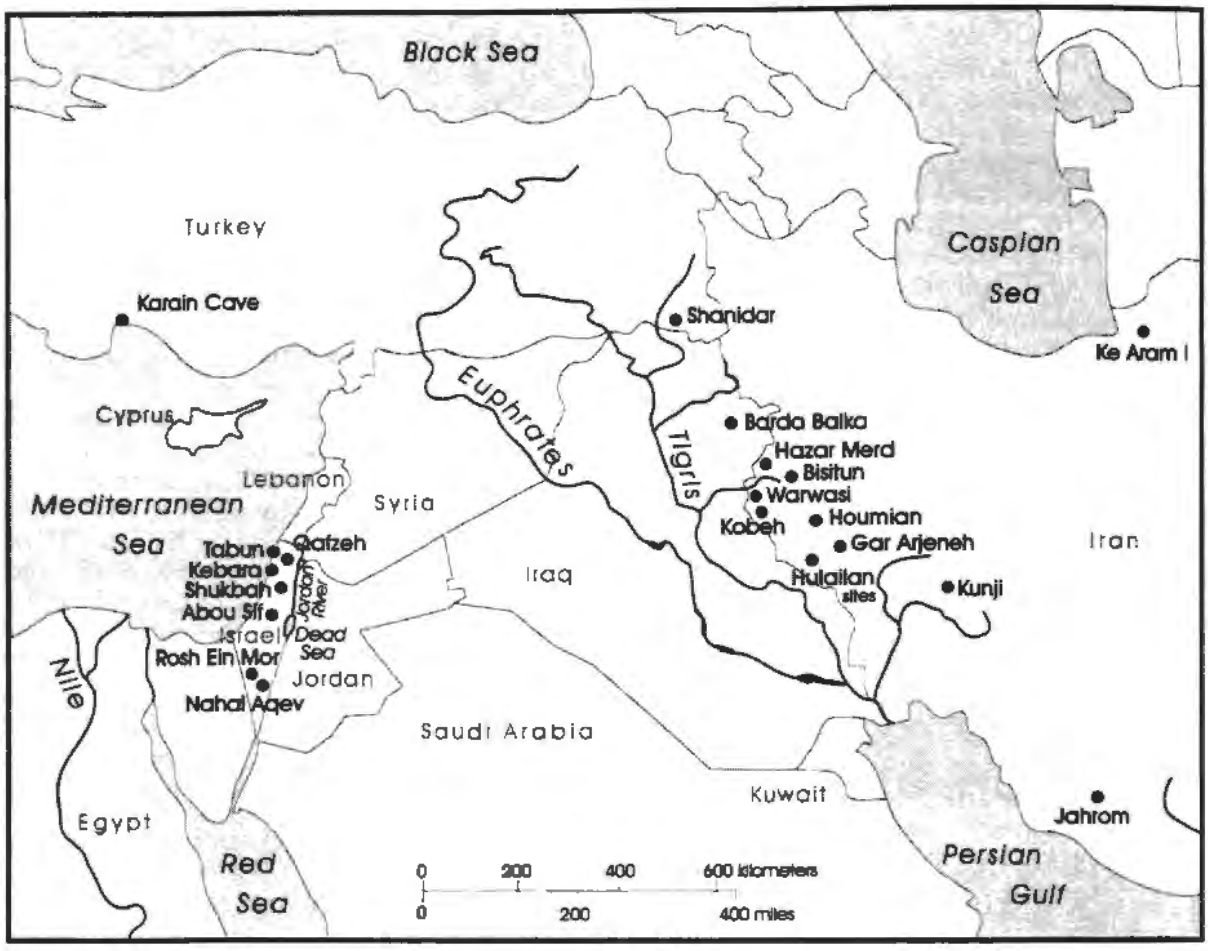


Figure 1. Location of sites discussed in the text (map by Donna Carpio/Carp Graphics).

Bisitun

Carleton Coon (1951, 1957) became involved with the exploration of caves in Iran during 1949. Bisitun Cave, near Kermanshah, was excavated and yielded a Mousterian industry very similar to that found by Garrod at Hazar Merd, except that there was a large flake and core component at this site. Unfortunately, Coon selectively threw out a large portion of the unretouched flakes.

Bisitun is interesting for its reported lack of hearths or fire features, although the front part of the cave was not excavated. This lack of evidence contrasts with that of Hazar Merd, where burned features were very prevalent. The "Neanderthaloid" radius recovered from the site is human but cannot be attributed to either Neanderthal or anatomically modern humans, and the other purported human fossil recovered, an incisor, was actually from a bovid (Smith 1986:22).

Tamtama Cave, located approximately 20 km north of the city of Rezaiyeh, was also excavated by Coon but was found to have a low arrifact density (only 7 pieces of flint recovered). Coon attributed this to the altitude of the cave, approximately 1,300 to 1,400 m above sea level. However, given that many of the Zagros Mousterian sites are at or above this elevation, this conclusion is questionable. A piece of a femur was recovered that was called "Neanderthaloid" but turned out to be from a deer (Smith 1986:22).

In addition, Coon found a Mousterian surface site at Khunik, in this same region, with no subsurface component. He also excavated a rockshelter near the town of Khunik, but the deposit was mixed and exhibited a reversed stratigraphy (Coon 1957:126). Middle Paleolithic stone tools were on the surface and modern material was buried deeper in the deposit.

Iraq-Jarmo Project

The investigations by Howe in the Chemchemal Valley of northeastern Iraq in 1951 were part of the Iraq-Jarmo Project of the Oriental Institute of the University of Chicago and the American Schools of Oriental Research under the directorship of Robert J. Braidwood, the first large-scale archaeological project in this region (Braidwood and Howe 1960).

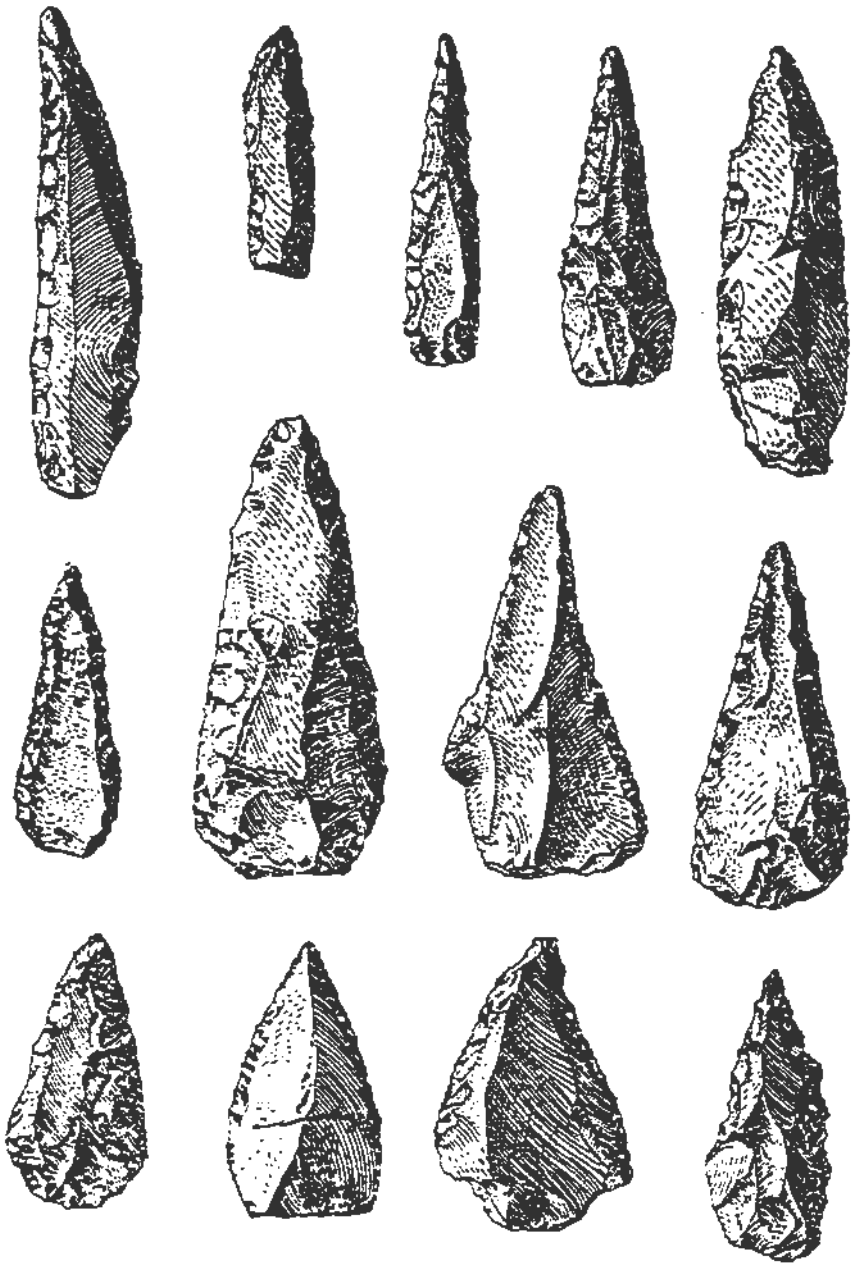


Figure 2. Artifacts from Hazar Merd, 2/3 scale (Garrod 1930:32).

The Lower/Middle Paleolithic site of Barda Balka was tested by Wright and Howe (1951) and found to contain handaxes, pebble tools, and a large flake component. This was the first occurrence of handaxes since those discovered by Garrod at Hazar Merd. The faunal remains and geology suggested to the excavators that this was a very old site, but there are no absolute dates to support this conclusion. The handaxe and pebble tool component analysis has not been published. The flake component was analyzed for the current research.

Howe also excavated Warwasi in the Tang-i-Knesht Valley in Iran (Braidwood and Howe 1960) and Gar Kobeh near Kermanshah in the Sar-i-Pol Valley. Both of these sites appeared to conform to the characteristics of the "Zagros Mousterian" (Skinner 1965), but Warwasi was never completely analyzed until recently (see below) and the results of an analysis of the Kobeh lithic assemblage are presented here for the first time (see Chapter 9).

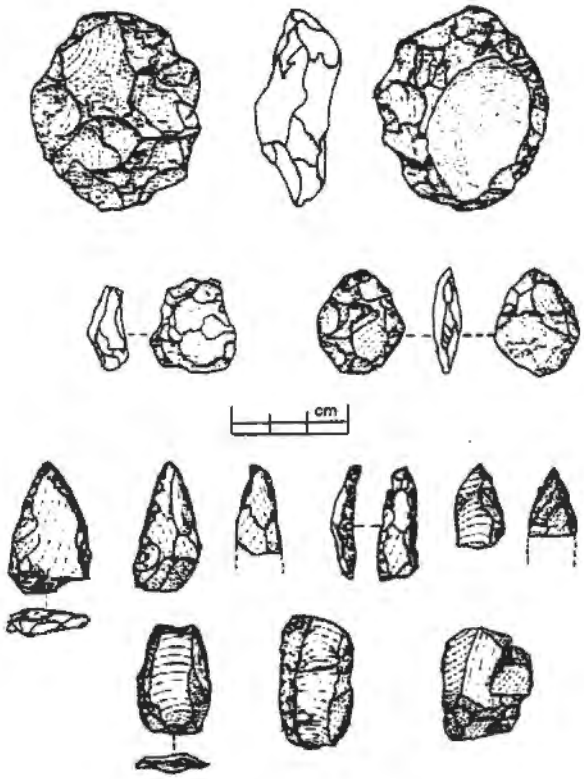


Figure 3. Artifacts from Ke-Aram I (from McBurney 1970).

Shanidar

Solecki (1955, 1963, 1971) began research in northern Iraq in 1951. Excavation began at Shanidar Cave in the 1951 season and was completed in a sounding during 1960. Owing to the large size of the site and the discovery of numerous Neanderthal fossil remains, Shanidar has become one of the most important Middle Paleolithic sites in the Zagros region (Akazawa 1975; Smith 1986; Solecki 1955, 1971; Solecki and Solecki 1993).

The lithic industry has been lumped with the Zagros Mousterian (Skinner 1965), although the complete analysis has not yet been published (see Chapter 9). Preliminary results, however, do suggest this industry is similar to other Zagros Mousterian sites.

The 1960s

Research in the Zagros continued during the 1960s with the discovery of more sites and with the first synthesis of the Middle Paleolithic stone tool assemblages found in the region.

Gar Arjeneh and Kunji

Hole and Flannery (1967) discovered 17 sites in the Khorramabad Valley in Luristan (Iran) in 1963 and 1965. Three of the sites, Kunji, Gar Arjeneh, and Ghamari Cave, contained Middle Paleolithic remains. The site of Kunji was re-excavated by Speth in 1969 (Speth 1971) but not published until more recently (Baumler and Speth 1993).

Hole and Flannery (1967:151) saw the Middle Paleolithic technology as part of an uninterrupted continuum with the Upper Paleolithic Barodostian and the Epipaleolithic Zarzian in this region. Continuity has been clearly demonstrated for the late Barodostian and Early Zarzian (unit 1) at Warwasi (Olszewski 1993:215).

Skinner (1965) made the first formal regional study of nearly all the available Middle Paleolithic flaked stone industries in Southwest Asia. He identified a Group A, or Zagros Mousterian, characterized by a lack of Levallois technique, faceted platforms, discoidal technique, moderate Quina retouch, high percentage of retouched points and sidescrapers, few denticulates, and no bifaces. The analysis of the sites of Shanidar D, Bisitun, Hazar Merd C, and Kunji was the basis for this grouping.

Cambridge University Archaeological Expedition

In 1963 Charles McBurney (1964) excavated the Mousterian site of Ke-Aram I in Mazandaran at the eastern end of the Elburz Mountains (Reshteh-Ye Alborz) in northern Iran, recovering lithic artifacts and faunal remains. This region is approximately 700 to 800 km east of the Zagros Mountains. Ke-Aram I is a cave site at approximately 1,000 m elevation in a dense forest zone 8 m above a stream that drains into the Gurgan (Gorgan) River. The cave measures 12 m wide and 20 m long and the excavation was over 6 m deep in some areas. The deposits in the cave appeared to be laid down by stream action and also "terrestrial" activity (McBurney 1964:386). McBurney compared the lithic artifacts to those of Teshik Tash in the former Soviet Union (Movius 1953) and also the Zagros site of Bisitun (Coon 1951), concluding there was greater affinity with the Teshik Tash material. Only 135 Mousterian lithic artifacts were recovered in the excavation and these averaged only 1.13 to 1.15 cm in width (Figure 3). The artifact types include points and scrapers. The faunal remains are dominated by red deer (abundant) but also contain pig and rhino. The carnivore remains recovered were a bear species (common), wolf, and a cat species. It is clear from the faunal remains that the area surrounding the cave during the Middle Paleolithic was forested. McBurney (1964:393–394) argues that, given the faunal data and elevation of the site, Ke-Aram-I could only have been occupied during a warm climatic episode such as an interglacial or interstadial. The only other Mousterian site that gives any indication of being occupied during a warm climate is Houmian 2a (see below). In addition, the presence of rhino at Ke-Aram I is only the second occurrence of this species at a Middle Paleolithic site in this region (the other is Barda Balka, in Iraq). The human occupation at this site had to have been

ephemeral at best. The presence of bear suggests the site was also a hibernation den where these animals died of natural causes.

McBurney (1970) organized the Cambridge University Archaeological Expedition to Iran in 1969 with the purpose of investigating the origins of the Upper Paleolithic. He proposed "to throw light on the expansion of the Upper Paleolithic blade industries in Southwest Asia, at the expense of the earlier Middle Paleolithic flake industries" (Bewley 1984). McBurney excavated the Middle Paleolithic site of Houmian, but it was not analyzed and published until 1984 (see below). Unfortunately, his goal of discovering the origins of the Upper Paleolithic of Europe in this region went unfulfilled.

The 1970s

The succeeding decade was characterized by surveys into the Zagros region. Many new areas were explored and new sites were discovered. However, few new sites were excavated. More recent surveys and excavations indicate the extent to which the Middle Paleolithic in the Zagros region is just beginning to be documented. The following is just a sample of research that has occurred in the 1960s and 1970s. In 1966 and 1967 Hume (1976) conducted a survey in Baluchistan in southeastern Iran of what appeared to be early Paleolithic sites related to Asian chopper–chopping tool industries. Piperno (1972) reported on a large surface site called Jahrom in Fars, central-southern Iran, discovered by Sumner in 1969, containing Middle Paleolithic artifacts that are argued to be different from those found at Zagros sites (Figure 4). In 1976 Wright (1979) surveyed Paleolithic sites in Khuzistan. Sadek-Kooros (1974, in Smith 1986) studied the relationship of Paleolithic artifacts to Pleistocene terraces in Azerbaijan.

More recently Mortensen (1974, 1993) surveyed in the Hulailan Valley of Northern Luristan and identified eight Middle Paleolithic sites. The three shelters and five open-air sites contained artifacts characterized as being "closely related to the so-called Zagros Mousterian assemblages" (Figure 5) (Mortensen 1993:165).

Smith located a large open-air site in the Kermanshah District that is identified as a workshop (Smith 1986). Smith also test-excavated the site of Ghar-i-Khar over a mountain spur, northeast of Bisitun in 1965, coming down on the top of Middle Paleolithic deposits when the excavation was terminated (Smith 1986; Young and Smith 1966). This site shows promise of being comparable to Bisitun if the opportunity to return to the area ever presents itself.

The 1980s to the Present

The 1980s saw the closing of the Zagros region to most research by Westerners. Researchers turned to the Taurus

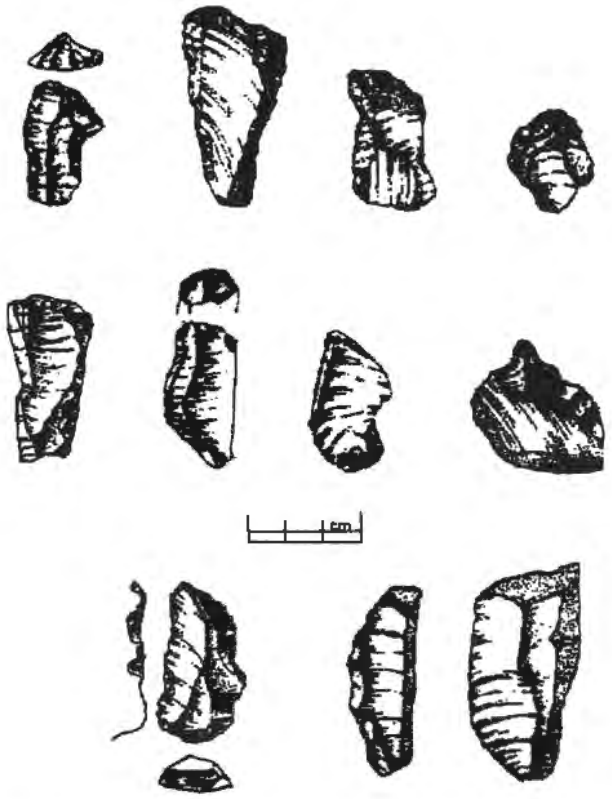


Figure 4. Artifacts from Jarom (from Piperno 1972).

region in Turkey and to the analysis of old collections that were previously unpublished.

The Taurus Region

The cave site of Karain located near Antalya in southwestern Turkey at an elevation of 440 m above sea level in the Taurus region has often been compared to Zagros sites (Minzoni-Deroche 1993; Otte et al. 1995; Yalcinkaya et al. 1993). Karain is actually a complex of cave sites in a mountainous area known as Katrain overlying a large plain and containing numerous springs. Chamber E contains the currently reported Mousterian and "Proto-Charentian" levels in deposits composed of silt-dominated and clay- dominated layers. The sedimentological analyses have not been completed, but the deposits in the cave have been modified by a series of processes that include such causal agents as water, hominids, and hyenas. Thick carbonate layers have accumulated throughout the deposit that sound remarkably similar to those found in Shanidar D deposits (see Solecki and Solecki 1993) and at other sites in the Zagros region. It is interesting that a sedimentological break between the Epipaleolithic and Mousterian levels is not usually visible but must be identified on the basis of artifact content. The deposit contains numerous faunal remains, including several hominid remains that have yet to be securely identified. The Mousterian industry was manufactured primarily on local raw material, although

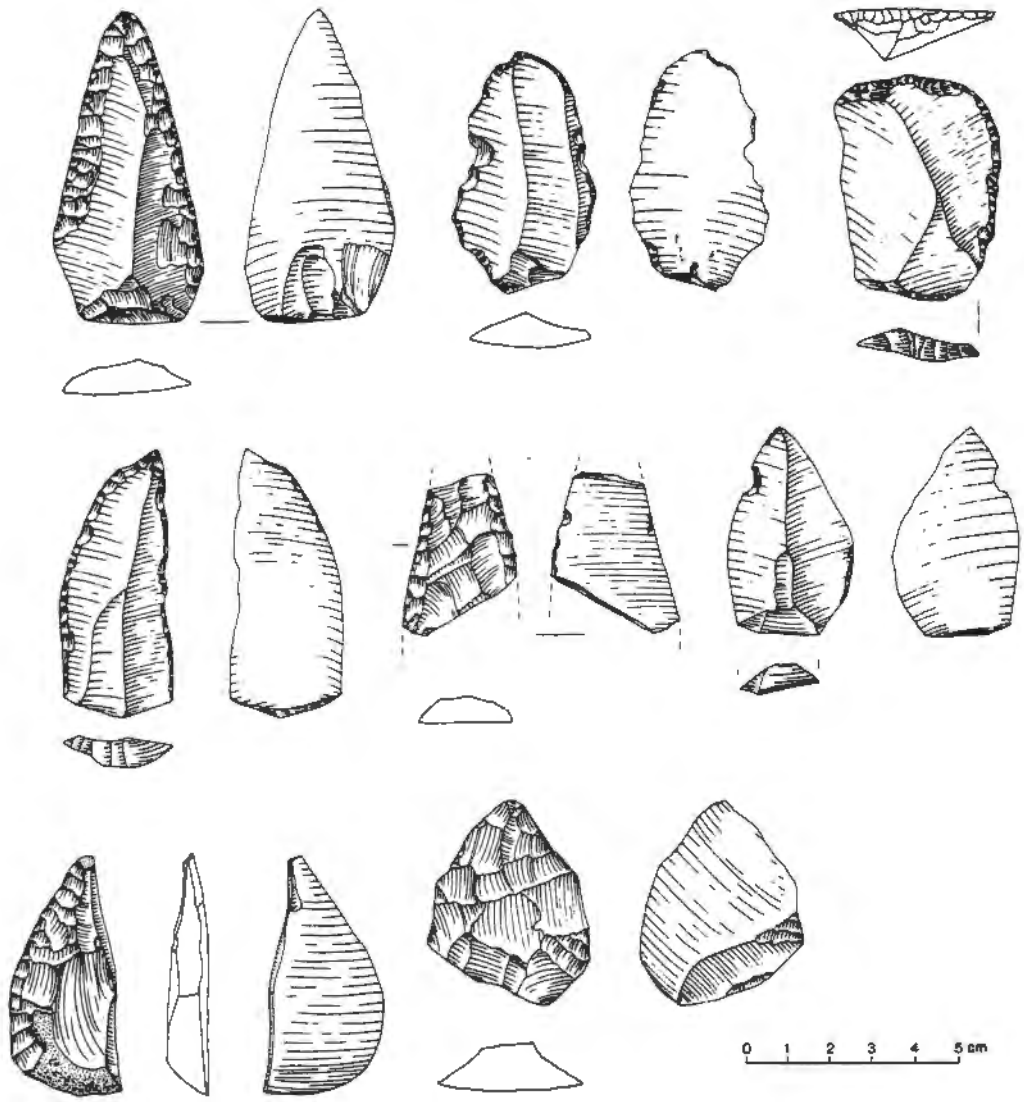


Figure 5. Middle Paleolithic artifacts from Hulailan Valley, Iran (Mortensen 1993:181).

some of the raw material appears to be from nonlocal sources (Yalcinkaya et al. 1993:103).

The Mousterian assemblages identified as Complex F through I are characterized by varying degrees of Levallois technique and laminarity and are dominated by heavily reduced scrapers that show similarities to those at Zagros Mousterian sites such as Bisitun and Warwasi (Otte et al. 1995). The frequency of retouched tools is high relative to unretouched flake blanks of similar size, which suggests to the excavators that part of the reduction sequence took place off-site (Figure 6).

Under these layers are the so-called Proto-Charentian levels of Complex B through E, which are characterized by thick blanks and dominated by denticulates and notches. The scrapers that are present in these levels are also made on thick flakes and have very abrupt retouch similar to the "Charentian" of Europe and the Acheulio-Yabrudian facies of the Levant. Complex A at Karain appears to be a Lower Paleolithic flake industry also dominated by denticulate tool types. Bedrock has yet to be reached at this site, and further information on the Lower Paleolithic levels should be forthcoming.

Other sites in the Taurus region include Cakmaktepe, an open-air site located on a large source of tabular lithic raw material 15 km northeast of Ulukisla, in south-central Turkey, at an elevation of 1,000 m (Minzoni-Deroche 1993). This quarry site apparently has a mixture of artifact types and knapping episodes from numerous time frames, and in fact, the local population was still using this raw material to make stone flakes for threshing sledges up to a few years ago.

Kocapinar is located 35 km from Karain in the Antalya province at 1,250 m above sea level. Lithic raw

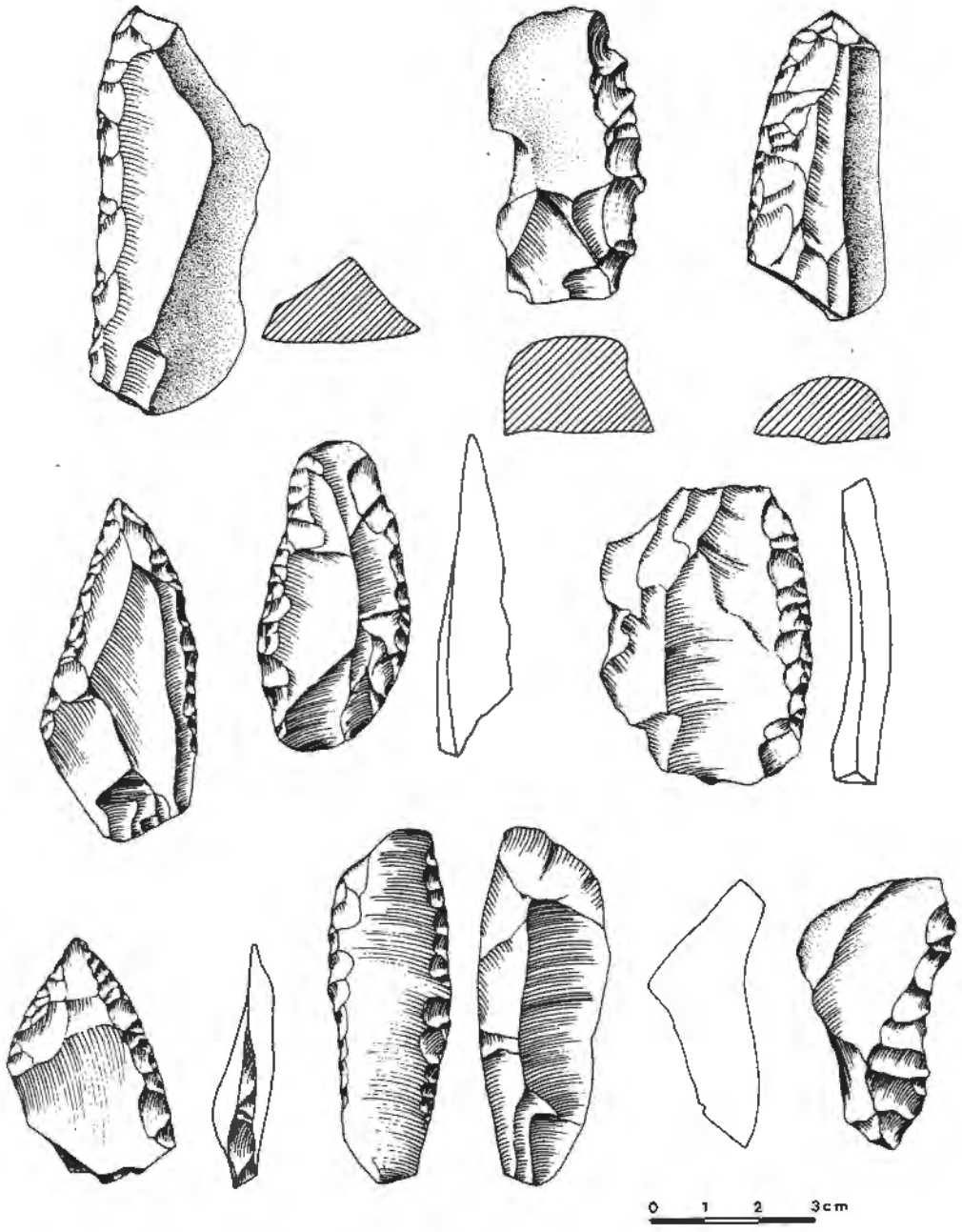


Figure 6. Artifacts from Karain Cave (Yalcinkaya et al. 1993:117).

material is abundant but the lithic assemblage is heavily reduced, being characterized by exhausted disc cores, thick flakes, and little Levallois technique. It is interesting to note that this is one of the few sites in the Zagros-Taurus region, along with Karain Complex B–E, with a tool assemblage in which denticulates and notches are considered common along with scrapers (Minzoni-Deroche 1993:148; see also the results of Barda Balka analysis, Chapter 9).

New Analyses of Old Data

Recently, researchers have analyzed or reanalyzed old collections from excavations completed in the 1950s through 1970s. Dibble (1984b) reanalyzed the Bisitun collection housed in the University Museum at the University of Pennsylvania. He concluded that both Coon (1957) and Skinner (1965) had missed several key features of the assemblage, including the presence of Levallois technology and truncated / faceted pieces

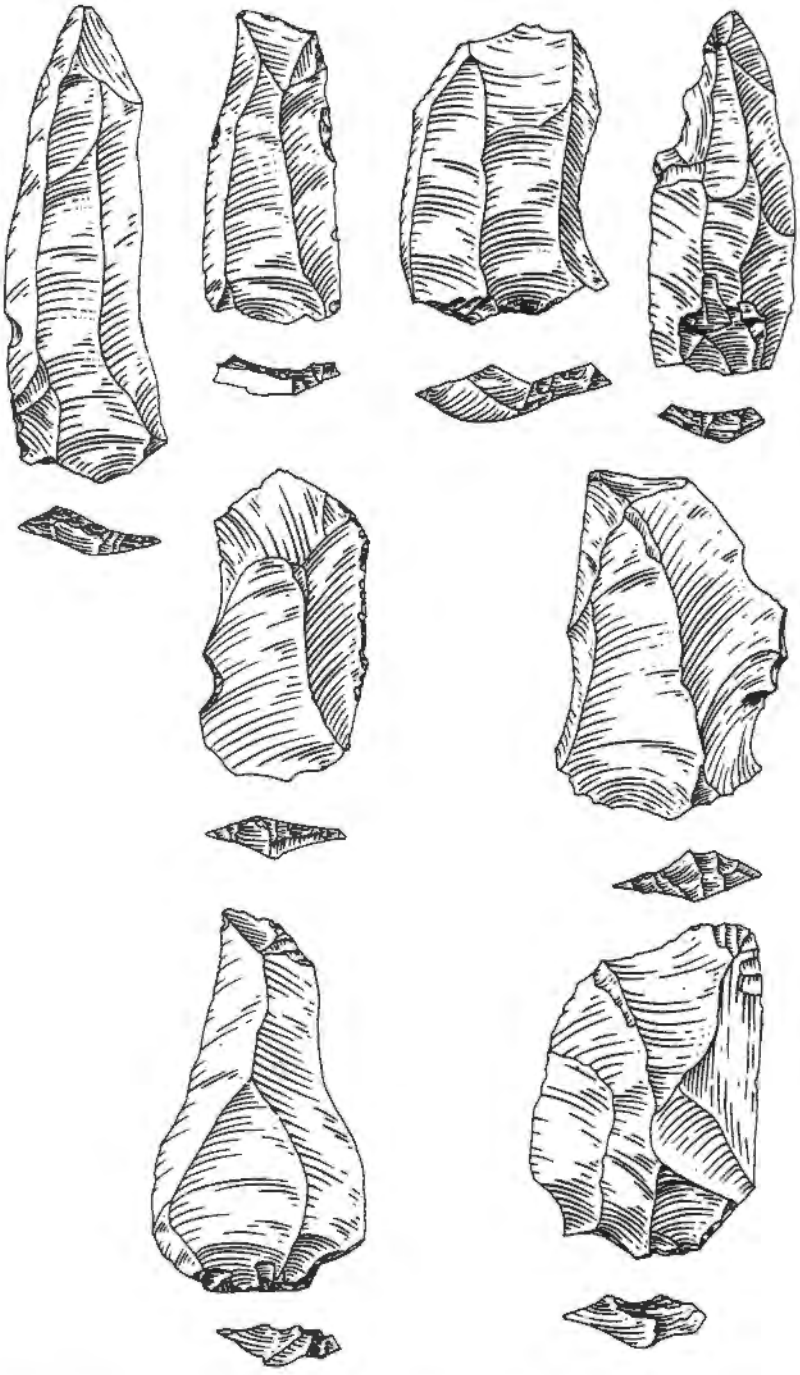


Figure 7. Artifacts from Bisitun (from Dibble 1984b:29).

(Figure 7). Dibble's study was the first to suggest there was more variability in the Zagros Mousterian than had been noted by Skinner (1965).

Baumler and Speth (1993) analyzed the 1969 excavation material from Kunji and concluded that the tools were heavily retouched but did not conform to Dibble's reduction model (however, see Dibble 1995a for a rebuttal). There were few cores, cortical flakes, and debris in the sample, which suggested that some of the tools were brought to the cave from elsewhere (Figure 8). The raw material utilized is the same cobble radiolarite found at other sites in the region. The Kunji 1969 assemblage has all of the characteristics of the "Zagros Mousterian" (Skinner 1965).

Dibble and Holdaway (1993) analyzed the Warwasi collection excavated by Howe (Braidwood and Howe 1960). They demonstrated an increase through time in retouch intensity on tools and suggest there was

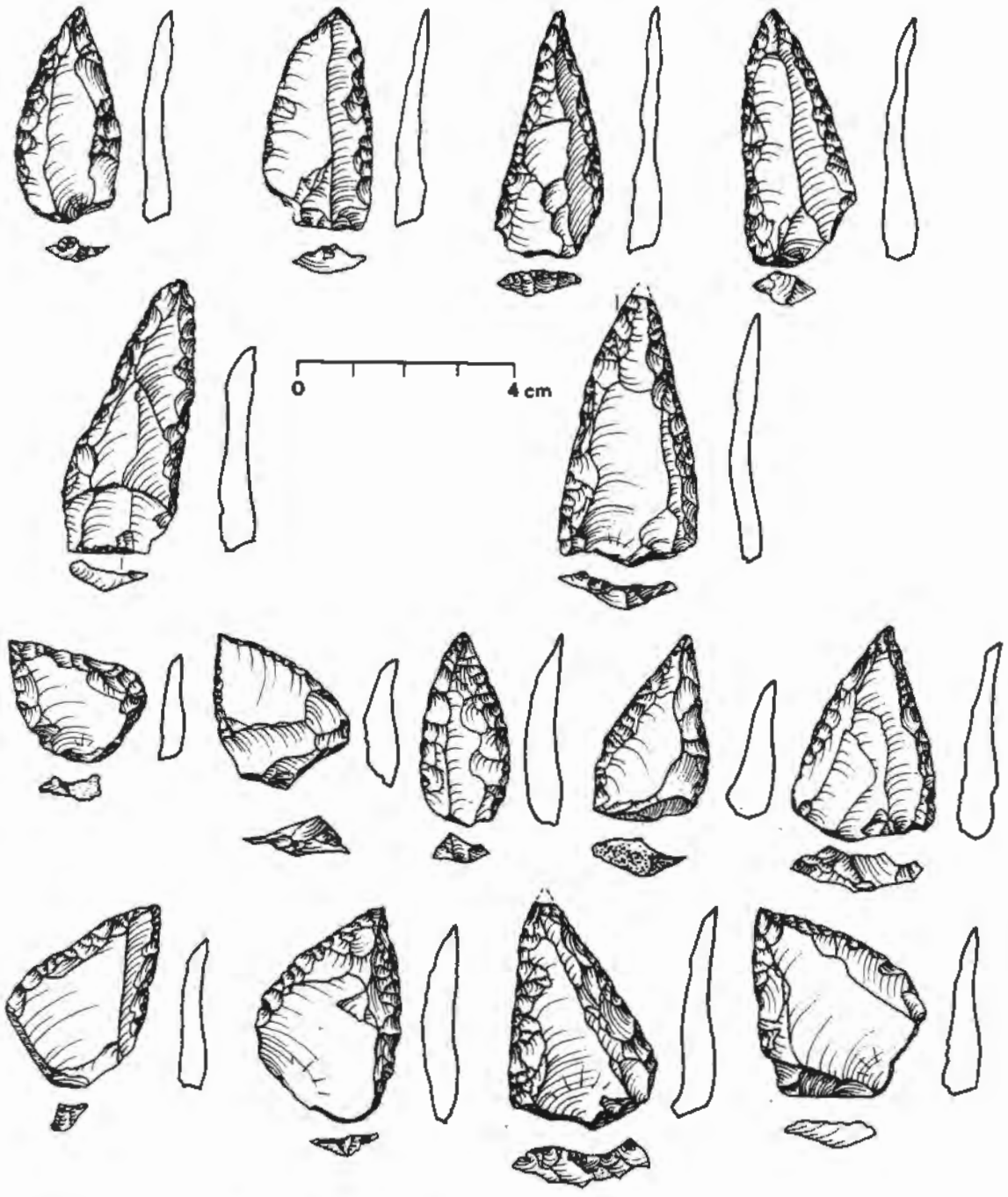


Figure 8. Artifacts from Kunji Cave (Baumler and Speth 1993:65).

increasing stress on raw material. Truncated/faceted pieces are common, and all stages of reduction appear to occur on-site. The authors conclude this site is very similar in assemblage composition to other Zagros Mousterian sites in the region, with a tool component dominated by heavily resharpened scrapers (Figure 9). A detailed discussion of these data occurs in Chapter 8.

Houmian

In 1969, McBurney led an expedition whose original goal was to go to the Hazar-i Masjid mountain range in northeastern Iran but had to settle on investigating the province of Luristan in western Iran. Near the town of Kuh-i Dasht, in west-central Iran, at an elevation of 2,000 m, the expedition investigated a series

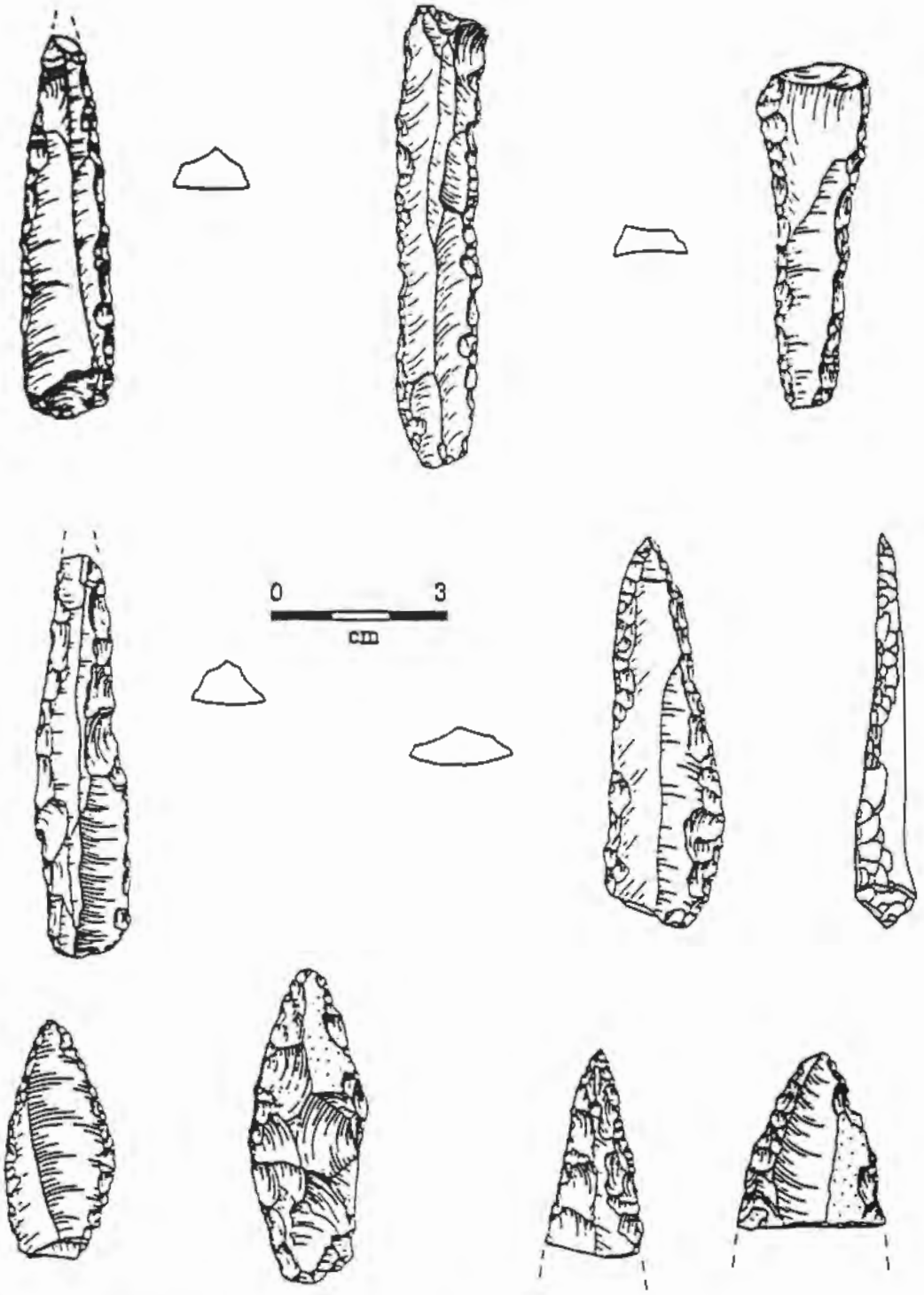


Figure 9. Artifacts from Warwasi (Dibble and Holdaway 1993:94).

of rockshelters on a limestone ridge. These rockshelters were mentioned by Claire Goff (1980) as "painted caves."

Three rockshelters were tested: Houmian, Barde Spid, and Mir Malas. Only Houmian contained Paleolithic remains, and these were analyzed by Bewley (1984) in 1979.

Houmian rockshelter measured 25 m by 8 m and the excavation was conducted during one week in August 1969. In seven "cuts," excavation was done in

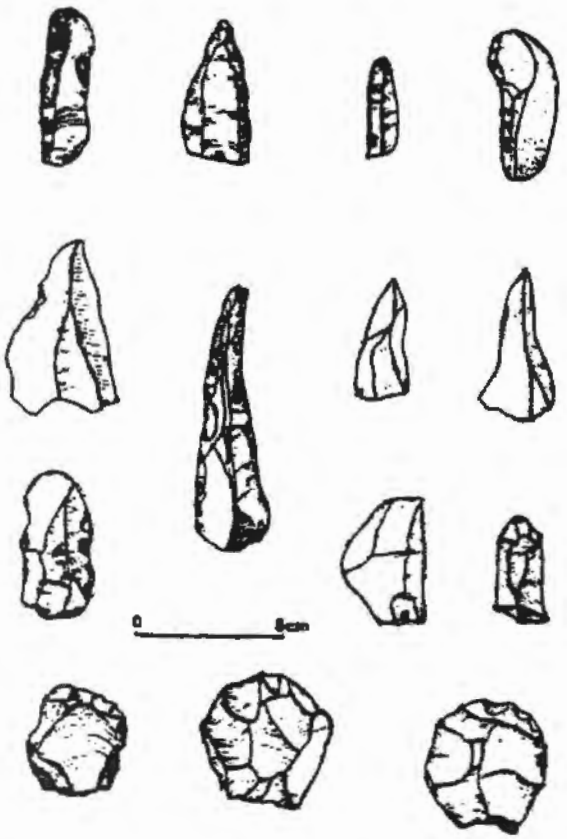


Figure 10. Artifacts from Houmian (from Bewley 1984).

spits that varied from 15 to 25 cm deep and exposed 10 layers of deposit. Five to ten cubic meters of deposit were excavated. The site is one of the few in the Zagros region for which pollen, faunal, and sedimentological analyses have been completed. The environmental indicators suggest a climatic amelioration during the densest occupation of the site (layer 2a). Bewley (1984:35) suggests that because the site is located at 2,000 m above sea level, it only could have been occupied during a warmer period and even then only seasonally in the summer months.

Bewley analyzed 887 pieces of chipped stone and compared the assemblage with those from other Zagros Mousterian sites, including Skinner's (1965) Group A. He concluded that the lithic assemblage from Houmian was similar in some ways to other Zagros Mousterian assemblages, including the presence of sidescrapers and Mousterian points (Figure 10). He noted a greater amount of Levallois technique at the site in contrast with the sites in Skinner's (1965) study, such as Bisitun, Kunji, and Shanidar. However, Dibble's (1984b) reanalysis of Bisitun and Warwasi (Holdaway and Dibble 1993) suggests that Skinner's identification of "Levallois technique" might have been conservative. Skinner subscribed to a restricted definition of Levallois that comprised radial preparation, faceted platforms (including Chapeau-du-gendarme), and "thin" flakes. Neither Bisitun nor Houmian conforms to this ideal. Yet, Levallois has been identified (using a more relaxed definition) at Houmian, and the Levallois method is not as rare as once believed in the Zagros region. The faunal remains from this site are described in Chapter 3.

Summary

The history of research on the Zagros Middle Paleolithic is really quite brief compared with other areas of Southwest Asia and the Old World in general. Yet, the Zagros can be seen as a distinct region that contains a very distinct Mousterian industry.

The early excavations and regional analyses described an industry unlike that of the Levant or Western Europe, although inevitable comparisons were made to these regions. This industry was originally characterized by heavily retouched scrapers and a lack of Levallois technique, denticulates, and bifaces.

Later studies attempted to classify new Middle Paleolithic assemblages from the region based on their similarity to those from the previously described sites, specifically Bisitun, Hazar Merd and Shanidar. The problem with this approach is that none of these sites can or should be used as the regional "type site." We cannot expect any one site to contain all the technological characteristics of a region. In addition, at each of these sites are specific problems arising out of sample size and sample integrity (see Chapter 8).

Bisitun was subjectively collected by Coon, who threw away a huge amount of debitage during excavation and thereby biased any analysis of the assemblage. Hazar Merd contained a very small number of artifacts, hampering its use for comparison owing to small sample size and possible discard of material. Shanidar has never been completely published, with collections presently stored in both the US and Iraq, and the number of lithic artifacts recovered from Middle Paleolithic layer D is quite low.

Finally, new studies revealed aspects of the lithic industry that had not been noted before, such as the presence of Levallois technique and truncated/faceted pieces. The identification of Levallois technology and what it means in terms of a lithic industry is still controversial (Dibble and Bar-Yosef 1995; and see Chapter 8). In addition, the function of truncated/faceted pieces has yet to be determined (see Chapter 7). All in all, however, we still know very little about regional technological organization of the Zagros Mousterian.

With the addition of my analysis of Bisimn, Kobeh, Kunji, Gar Arjeneh, Warwasi, Barda Balka, and Shanidar, we should be closer to understanding this time period and region so critical to our views of Upper Pleistocene adaptations. The following chapter describes the climatic conditions that existed during the period in which these sites were occupied.

3

The Environment

Paleoenvironmental reconstruction of the Pleistocene began early this century with the advent of Glacial Theory, which used stratigraphy in the European Alps to present a sequence of four major glaciations: Gunz, Mindel, Riss, and Würm, separated by 3 major interglaciations (Flint 1971:643). This sequence became the standard for most of Europe and was used to some extent for the Zagros Mountains as well (i.e., Wright 1952:22, 1960:71) and still is the time frame used by some workers in the Levant (e.g., Horowitz 1979). Unfortunately, the alpine sequence does not generalize well to any other area of Europe (including, strangely enough, areas of the Alps themselves) and is a very inaccurate reflection of climatic fluctuations during the Pleistocene. In addition, these traditional periods are difficult to apply in the Near East because they are nearly impossible to correlate with the local sequences (Farrand 1982:105).

New evidence from the past several decades suggests there was more fluctuation in sea level, and therefore climate and glaciation, throughout the Old World than is indicated by the European sequence.

Deep Sea Cores

Emiliani (1955, 1958, 1964, 1970) was the first to investigate the oxygen isotope record for the Pleistocene. He demonstrated fluctuations in the $^{18}O/^{16}O$ ratio of foraminifera from deep sea cores taken in the Caribbean and Atlantic Ocean. Emiliani suggests these variations reflect the changes in the quantity of sea water contained in the world's oceans versus the amount of water in ice sheets and consequently between glacial and interglacial climates, and he identified oxygen isotope stages that reflected these shifts.

Shackelton and Opdyke (1973) further demonstrated the validity and the global extent of this model. They identified 22 isotope stages spanning the past 900,000 years. These stages have been absolutely dated by potassium-argon and uranium-thorium methods. The isotope stages of interest to the study of the Middle Paleolithic would be stages 3 to 7 (Figure 11), although given recent earlier dates from Tabun (Mercier et al. 1995), stages 8 to 11 may also be of interest (these earlier stages will not be described).

Stage 7 was a warm interglacial period dated from approximately 190,000 to 240,000 years BP with at least one period of return to more glacial conditions around 225,000 years BP. Stage 6 was a cold period that correlates with the Riss Glacial and is dated from 130,000 to 190,000 years BP. Isotope stage 5 is characterized by oscillations from fully interglacial conditions (5e), to glacial conditions (5d and 5b), alternating with milder interstadial episodes (5a and 5c) from 126,000 to 75,000 years BP. Stage 4 lasted from 75,000 to 60,000 years BP and marks the return of much colder conditions. Stage 3 lasted from 60,000 to 25,000 years BP and is characterized by an overall milder climate but also with at least 12 oscillations over this period from warmer to colder. Some of these climatic shifts were of such a short duration that they are difficult to document using other evidence, such as pollen (Mellars 1996:26), and do not necessarily correlate with terrestial climatic conditions. The first part of stage 3, the end of the Middle Paleolithic period of concern here, appears to have been milder and wetter than the conditions of stage 4 (Bar-Yosef 1992:203).

This chapter will attempt a very coarse-grained reconstruction of the environment of the Zagros Mousterian sites under study. First, background data is presented on the topography, vegetation, geology, climate, pollen, and fauna of the Zagros region.

The Zagros

The area that we call the Zagros is located in the countries of Iran, Iraq, and in eastern Turkey. It extends 1,600 km from Azerbaijan in the northwest to the Persian Gulf. The region has further been subdivided into northwest, central, southwest, and southern Zagros subregions based on different local conditions (Fisher 1968). These local conditions can be very different from one subregion to the next and even from one valley to the next owing to physical isolation caused by the local relief in these highlands.

In general, the natural vegetation of the region, which has been heavily affected by intensive grazing of sheep and goats, consists of oak, almond, and other deciduous trees. Wild wheat and barley, along with wild goat, sheep, boar, deer, and gazelle, still exist in the area.

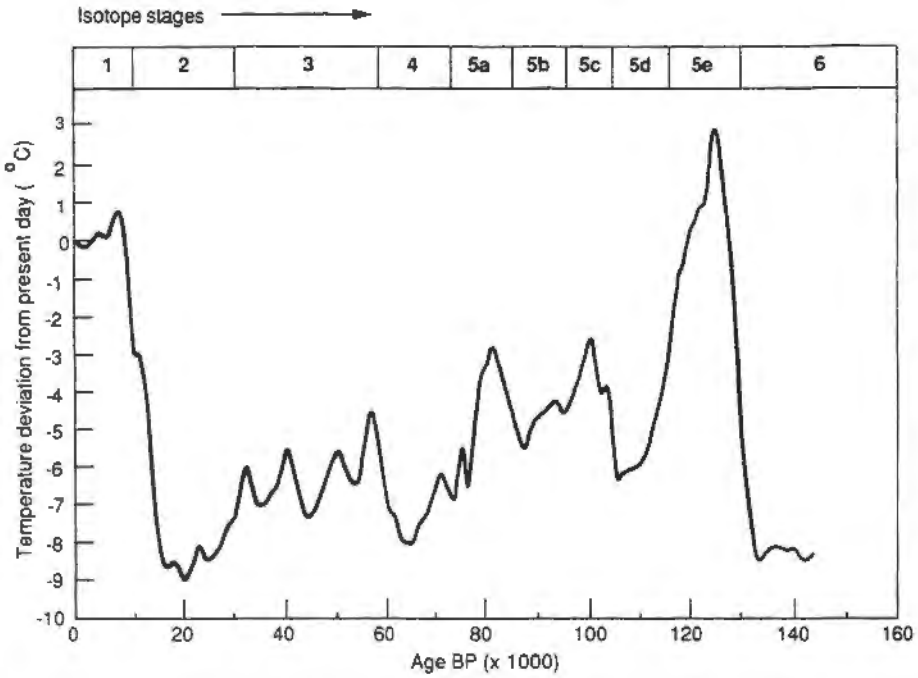


Figure 11. Temperature variation and isotope stages for the past 140,000 years (Mellars 1996:10, Fig. 2.2).

Geology

The central Zagros system can be divided longitudinally into an "inner" or older Zagros and an "outer" or younger Zagros. The inner Zagros includes the northeastern half of the highland and is a zone of thrust faulting. The structures of this zone were caused by periods of compression begun in the Cretaceous (Oberlander 1965). The outer Zagros includes the southwestern half of the highlands and is the product of strong folding produced by late Pliocene orogeny. The entire region is very active seismically with earthquakes a regular occurrence today, in the Middle Paleolithic, and in earlier periods (Solecki 1971:125, 161–162; Berberian 1981).

Topographically, the Zagros mountain chain consists of long, parallel limestone anticlinal ridges rising to 4,000 m above sea level and divided by intermontane valleys etched out of younger shales, sandstones, and gravels at an elevation of 600 m to 1,200 m above sea level (Wright 1952:12-13). Rivers and streams flow into the Caspian Sea, the Persian Gulf, and several lakes. This drainage pattern is considered anomalous as the streams and rivers flow transverse to the structure and obstructions of the surrounding rocks (Oberlander 1965). During stable periods the streams bring gravels and clay, creating layers of alluvium on the valley floors from erosion of the surrounding mountains (Mortensen 1993).

Climate

Today the western side of the Zagros receives more precipitation than the eastern side, which is in a precipitation shadow and has cooler, dryer winters. Individual valleys can contain several environmental zones. Snowfall is heavy and the melt can have important effects on the environment through the replenishment of groundwater and springs.

Climate reconstruction for the Pleistocene in the Zagros is difficult to provide. The temperature was intermittently colder during the Pleistocene, although there is no consensus about how much colder with estimates ranging from 3–4 °C to 11 °C (Wright 1980). A moderate estimate is ca. 5–8 °C lower than the present (Smith 1986; van Zeist and Bottema 1977). The snow line would have been between 1,200 and 1,800 m below the modern snow lines during colder periods, and there would have been small glaciers (Wright 1960). Others have argued for a snow line that was depressed 760 m to 2,900 m during the Pleistocene. Wright (1960) documented glacial moraines below 1,300 m, small cirques as low as 1,600 m, and glacial till at 1,100 m.

The upper treeline is at approximately 2,200 m elevation today, although this boundary is probably more a reflection of historic and modern overuse than climatic limitations. It would have been much lower during cold periods of the Pleistocene. Wright (1960:90) suggested an annual snow line (the boundary or separation of the snow-covered upstream portion of a glacier from the bare-ice downstream part) of approximately 1,300 m and an upper tree line below 700 m during the last glaciation. It is interesting to note that all of the Zagros Mousterian sites in this study fall within this elevation range (Table 1) and that many of the sites analyzed here would have

Table 1. Middle Paleolithic site elevations and exposures.

Site	Elevation (masl)	Exposure
Barda Balka	740	open
Shanidar	745	south
Hazar Merd	1,200	north
Bisitun	1,400	south
Warwasi	1,300	east
Kobeh	1,300	south
Kunji	1,300	west
Gar Arjeneh	1,200	west
Houmian	2,000	north

been under snow during most of even a warm year and could have been under glaciers or snow for hundreds if not thousands of years during colder periods. In fact, Coon (1957:95) could not find the cave he eventually excavated at Bisitun during his first visit on December 31, 1948, because it was completely filled in with snow.

Pollen

Very few pollen analyses have been completed for any of the Zagros Mousterian sites. Pollen cores obtained from lake deposits do not cover time periods before 42,000 years ago. However, pollen studies from both Shanidar and Houmian suggest, for the most part, cold climatic conditions with arboreal pollen of less than 25%.

The topmost Middle Paleolithic layer at Shanidar (D1) shows "a trend to a wet climate" (Solecki and Solecki 1993:121). Layer D4A, near the base of the cultural deposits, is labeled as cold and moist by trace element analysis, and this interpretation is supported from pollen evidence as well (Solecki and Solecki 1993:122).

At Houmian, Leroi-Gourhan analyzed a section extending from layer 10 (greater than 3 m below datum) at the bottom of the deposit to layer 1 (approximately .90 to 1.00 m in depth) at the top (reported in Bewley 1984:30). The environment around the site was steppic in layers 7–10 with little arboreal pollen but with some indication of moist conditions denoted by of the presence of fern species, although these might have been endemic to a cave environment. These steppic conditions continue in layer 6 to lower 2a, although the environment becomes cooler and dryer. Layer 6 apparently contains almost no arboreal pollen, suggesting extremely cold and dry conditions. At the end of 2a arboreal pollen shows a marked increase to nearly 80%. The predominance of oak, including a Mediterranean species, along with an increase in fern species point to an increase in both temperature and moisture. As Houmian is situated at 2,000 m above sea level, the climatic amelioration seen in layer 2 must have been enough to raise the treeline to nearly modern levels. In fact, the majority of lithic artifacts and faunal remains recovered from this site are from layer 2a, suggesting a greater use of the cave during this period.

Faunal Remains

Faunal analyses are also rare for Zagros sites. This may be due, in part, to the extremely fragmented nature of the bones recovered from these sites and also because many of the faunal remains recovered in earlier excavations were not saved for study. Table 2 summarizes the fauna in terms of the presence and absence of genera from Zagros Mousterian sites presented below.

Bate (in Garrod 1930:38) found the fauna at Hazar Merd to be broken so badly that no piece was greater than 15 cm in length. Nonetheless, the presence of goat, gazelle, and deer was noted.

Levine (in Bewley 1984:25) saw the same severe fragmentation at Houmian. Caprids dominated the

Table 2. Faunal remains from Zagros Middle Paleolithic sites.

Site	Equus	Cervus	Ovis/Capra	Sus	Bos	Gazella	Carnivores
Barda Balka	+–	+	+	+	+	–	–
Shanidar	–	–	++	+	+	+	+
Hazar Merd	–	–	+	–	–	+	–
Warwasi	++	–	++	–	+	–	–
Bisitun	+	+–	+	+	+	+	+
Kobeh	+	+	++	+	+	+	–
Gar Arjeneh	n/a	+	n/a	n/a	+	n/a	n/a
Kunji	+	++	++	+	+	–	+
Houmian	+	+	+–	+	–	–	+

n/a = data not available

– presence of this genus at a site
+– most common genus at a site

identifiable bone at this site. However, wild pig, red deer, onager, and an unidentifiable larger species of ungulate, possibly aurochs, are also present. There was no way to determine the relative abundance of each species from the published results.

Faunal remains from Gar Arjeneh in the Khorramabad Valley apparently represented individual episodes of consumption, first of red deer, then two separate instances when parts of aurochs were dismembered and consumed, enabling the excavators to label this site a "butchering station" (Hole and Flannery 1967:163–164). Unfortunately, no bone counts or MNIs are presented.

The site of Kunji was labeled a "seasonal base camp" and apparently contained the same range of species found at other Zagros sites, i.e., goat, sheep, red deer, onager, gazelle, wild pig, and aurochs along with many smaller birds and mammals (Hole and Flannery 1967:161). However, bone counts and MNIs are not given for any of the faunal remains.

Shanidar faunal remains were dominated by wild goat and wild pig, along with gazelle, roe deer, and several carnivores, including wolf, fox, and brown bear (Evins 1982). Caprines are present in every Mousterian level, along with tortoise. Carnivores tend to be more numerous in upper levels, especially between 7 m and 9 m in depth. Evins (1982:54) suggests a catastrophic mortality profile for Shanidar caprines because the ages of the animals killed mirror that of a living population. She concluded these animals could only have been procured by driving herds or large family groups off cliffs; in other words, coordinated and organized hunting. However, Stiner (1994:297) has shown that ambush hunting will also produce such a "living structure" mortality profile.

Barda Balka faunal remains were described as "friable," but those that were identifiable suggest an assemblage dominated by onager with a few fragments attributed to aurochs, wild goats/sheep, gazelle, and two species of cervid, possibly roe deer and red deer (Wright and Howe 1951:109). A single molar each of elephant and rhinoceros were also recovered. Tortoise and snail shell fragments were also present.

Warwasi faunal remains were few in number, consisting of 31 identifiable bones and 86 teeth in the Mousterian layers. The assemblage is dominated by onager and wild goat/sheep but also includes sparse remains of wild pig, wolf, and hyena (Turnbull 1975).

Bisitun was also found to contain a great deal of splintered long bone that was identified as being two-thirds red deer and one-third horse (Coon 1957:109). Coon noted very few articular ends, teeth, or horn cores. In contrast to other Zagros Mousterian sites at this elevation (1,400 m), wild goat/sheep apparently were only a small part of the overall meat intake.

Analysis of the faunal remains from Kobeh shows highly fragmented long bones and an assemblage dominated by wild goat/sheep. In addition, based on refitting the long bone fragments at the site, there is clear evidence for hunting by the inhabitants of Kobeh (Marean and Kim 1998).

The majority of species found at each site are modern or existed in this region during recent times. Elephant and rhinoceros were found only at Barda Balka (although rhino was excavated at Ke-Aram I in northern Iran), leading some to suggest a more ancient age for these deposits. It should be kept in mind, however, that both elephant and rhino were historical residents of the Zagros region. In addition, the presence of one tooth per species at Barda Balka is less than overwhelming evidence for predation or scavenging. Because both species must live near plentiful plant food sources, the higher elevations, where most of these sites are located, would be less than ideal for these large herbivores, and they would be less likely to have been available as prey.

Tortoise is found only at Shanidar and Barda Balka. It is not clear if this is due to tortoises preferring lower altitudes or some other factor.

Some general patterns can be noted for faunal remains at these sites. First, sites can be grouped based on three dominant prey ungulates: horse, red deer, and goat/sheep. Barda Balka and Warwasi have predominantly horse remains. Bisitun and Kunji have a majority of red deer. Shanidar, Kobeh and Houmian are dominated by wild goat/sheep remains. However, goat/sheep make up a significant portion of fauna recovered from Kunji and Warwasi as well.

Second, additional prey species were taken, but they normally only account for one or two animals per site or deposit. However, this suggests that the Middle Paleolithic groups inhabiting the Zagros would "take" any prey species, either through hunting or scavenging, if the opportunity presented itself.

Finally, the carnivore bones recovered from these sites make up a small percentage of the overall remains. This suggests that carnivores played a relatively minor role in the accumulation of these bone assemblages (Lindly 1988).

Summary

The prevailing Pleistocene environment of the Zagros region would have been, for the most part, very different from what can be seen there today. The permanent snow line would have intermittently occurred at approximately the same elevation as Bisitun, Gar Arjeneh, Hazar Merd, Kobeh, Kunji, and Warwasi (Table 1), making these sites uninhabitable during the much colder periods in the Upper Pleistocene, even in the summer months. Houmian would have been above the average snow line by nearly 800 m and therefore inaccessible during all but the warmest periods.

Barda Balka and Shanidar are located at the approximate Pleistocene treeline, but we know little of

the paleovegetation except that arboreal pollen was never very high. However, the grasses and other vegetation were sufficient to support a diverse ungulate population, which in turn supported archaic hominids at least during some periods.

The ungulate species found at these sites are essentially modern. There is no indication of extinct, cold-adapted species being prevalentAlthough the potential time span encompassed by these sites could be on the order of 100,000 years, there is little variability in the kinds of animals recovered. From the above data, we can at least speculate about the environment during the Middle Paleolithic.

First, although the climate was probably colder than today, the permanent snow line had to be above 1,500–1,800 m during the occupations of these sites, and above 2,100 m for Houmian, or these locations could never have been occupied. This suggests that these sites could not have been occupied during full glacial conditions (except perhaps Shanidar or Barda Balka). The faunal remains recovered from the sites support this argument.

Second, if it was cold and moist throughout Shanidar layer D and it was cold and dry at Houmian layers 6 through 2a and then warm and moist at the top of 2a, there is no possibility of correlating these sequences with one another without further information. It is likely that the tremendous difference in the elevations of these sites and the aspect of the caves (Houmian faces northeast and Shanidar has a southern exposure) resulted in differing conditions, especially in terms of the plants in the surrounding area.

When these data are compared with oxygen isotope stages that are dated to before 40,000 years ago (see chronology in Chapter 4), it is clear that the levels at Shanidar could have been deposited during isotope stage 4 or 5 and Houmian could only have been deposited during isotope stage 5e.

As described previously, stage 4 is cold and dry and is dated to 70,000–45,000 years ago. This seems to match the Shanidar sequence well, especially if ^{14}C dates at the top of layer D are correct. There is no evidence at Shanidar for interstadial or interglacial conditions, and this may rule out site formation during the fluctuations present during stage 5.

The Houmian sequence of cold conditions capped off by very warm and moist conditions is different from Shanidar. Isotope stage 5e is considered to be the last interglacial and was both moist and warm (Bar-Yosef 1992:202). Stage 6 was a dryer and colder period and could be related to levels 6 through the base of level 2 at Houmian. Level 2a, with an 80% arboreal pollen result, could have been deposited during stage 5e. The cave was not occupied after this period of the Middle Paleolithic, perhaps owing to fluctuating climatic conditions in stage 5d to 5a and the cold conditions of stage 4. The environment was never again warm enough for an occupation at 2,000 m in elevation.

Unfortunately, the above scenario cannot be confirmed without more faunal and soil samples from these sites to provide the necessary pollen analyses, trace element studies, and sedimentary analyses. Along with dating, to be discussed in the next chapter, it is only through understanding these data that we can put together a clear paleoenvironmental picture of the Zagros Middle Paleolithic.

4

Chronology

The dating of Middle Paleolithic sites in Southwest Asia has, until recently, been problematical because most of these sites were deposited outside the range for C dating (ca. <50,000 BP). Exacerbating this problem is the fact that the sites in the Zagros region were excavated before newer dating techniques such as thermoluminescence (TL), electron-spin-resonance (ESR), and uranium series decay were in use, and opportunities to return to this region to implement a dating program will probably not soon be forthcoming.

Radiocarbon dates do exist for the site of Shanidar, in northern Iraq. The youngest Mousterian date occurs near the top of layer D at 46,000 ± 1500 (GRO 2527) and the other in the upper part of this layer at 50,300 ± 3000 (GRO 1495). The lower Baradostian levels (Upper Paleolithic) in layer C are dated at 35,080 ± 500 (GRO 259). In addition, two conventional carbon samples for Kunji from the second level yielded a date *in excess* of 40,000 BP (Hole and Flannery 1967).

At the site of Karain in southwest Turkey, the uppermost consolidated travertine layers were ESR-dated to 50–70 ky and the upper horizon of consolidated layers was dated by TL to 90 ky, both considered "Mousterian of Zagros or Karain type" by the excavators (Otte et al. 1995). The meter of deposits below this was also dated by ESR on a travertine deposit to 110 to 130 ky (Otte et al. 1995:290). This firmly puts Karain in the same time period as the Mousterian layers at Kebara and Qafzeh but after the Mousterian at Tabun layer C in the Levant.

Since the Levant has been extensively dated by several techniques, this region will play an important role in the following discussion, which will also deal with possible ramifications of the data for the Zagros Mousterian. As background for this comparison, a review of the environmental evidence from the Zagros and the Levant is presented.

The Zagros

Initial "dating" of Levantine Middle Paleolithic sites was accomplished through comparisons of stratigraphic sequences and the sedimentary and faunal/pollen content (Farrand 1979; Goldberg 1986). In the Zagros, only at Shanidar and Houmian have any palynological analyses been done (see Chapter 3).

Pollen

As outlined in Chapter 3, the pollen analysis of the Middle Paleolithic levels of Shanidar layer D suggest a cold, wet climate (Solecki and Solecki 1993). Arboreal pollen is never greater than 25% in layer D. A trace element study of the sediments at Shanidar by Sabels tends to support the evidence from pollen data (Solecki and Leroi-Gourhan 1961).

Houmian pollen analysis suggests cold and dry conditions from layer 6 through layer 2a (Leroi-Gouhran in Bewley 1984:30). However, at the end of layer 2a, arboreal pollen increases to 80% and the conditions appear to be both warmer and wetter.

Bewley (1984:32) uses the climatic amelioration in layer 2a at Houmian to suggest an interstadial and proposes a "Brorup" age for this upper layer of the site, or approximately 60,000 BP with a *terminus ante quem* estimate for the lower layers of 70,000 BP. However, this estmate was made before there were dates for the site (see below).

Unfortunately, a correlation of the pollen evidence from the two sites is not possible as there is no evidence at Shanidar for a warmer period around this (or any other) time, or in the pollen sequence at Zeribar at 42,000 BP where tree pollen never rises above 10% until the Late Glacial levels (van Zeist and Bottema 1977). It is possible, given the recently established dating of the Levantine Middle Paleolithic that considerably extended this period back in time, that Houmian was deposited before the Shanidar deposits. A thorium/uranium date on a bone fragment from layer 2a produced a date of 148,000 ± 35,000 BP appears to confirm this (Bewley 1984:38), although this dating technique is probably inappropriate on bone. If this very coarse-grained date is fairly accurate, it allows the placement of upper layer 2a at around isotope stage 5e dated to 128,000 years ago (Williams et al. 1988:61). This stage matches the environmental evidence from layer 2a quite well.

Travertine Layers

The presence of calcareous, stalagmitic "crusts," including speleothems, at several of the Zagros-Taurus Mousterian sites suggests similar environmental conditions were prevalent during the sites' formation. The Soleckis (1993) report calcareous layers at Shanidar in the Middle Paleolithic layers at D4b and at the base of D4c and layer D6. At Karain Cave in southwestern

Turkey, the calcite layers occur throughout the sequence, including unit I in which there are calcite deposits in nearly every Mousterian layer. Some layers in unit I, such as 2, 6, and 7, are composed entirely of these deposits, as is unit III, layer 1 (Mousterian) and layer 3 (Proto-Charentian), and unit IV, layer 5 (Proto-Charentian) (Otte et al. 1995). The excavators suggest these travertine layers represent interglacial phases. Bruce Howe (personal communication 1991) noted several "crust" areas at Kobeh during the excavation. Garrod (1930:29) describes a "thin crust of red bone breccia" at Hazar Merd at a depth of 1.25 m in sounding V at the rear of the cave, which she attributes to "dripping from the vault."

Interestingly, no crusts were reported by McBurney (1970) or Bewley (1984) at Houmian, possibly suggesting that different environmental conditions existed during the formation of deposits at this site than at the other Zagros/Taurus Mousterian sites discussed here. The thorium/uranium date from Houmian is older than the ESR dates from Karain and again suggests that not all these sites are contemporaneous. Unfortunately, without further dating of at least some of the travertine layers at different sites, there is no way to assign them to a chronological sequence.

The Levant

Paleoclimatic evidence is more prevalent and more plentiful in the Levant than in the Zagros. This difference is in part due to a longer research history in the Levant but also because of the greater number of modern excavations in this region.

Sediments

The deep stratigraphic sequence (more than 20 m) at the site of Mugharet et-Tabun, located on Mount Carmel in Israel, was used to organize other sites in the region into "the Tabun sequence" (Farrand 1979). The sediments from Tabun G to the top of Tabun D form a continuous sequence of deposition (Farrand 1979:373).

The stratigraphy at Tabun is complex, with several episodes of sediments having collapsed into solution cavities. The lower section of the sequence, classified technologically as Upper Acheulian and Acheulo-Yabrudian (associated with Garrod's layers G, F and the lower half of E), is composed of a sorted, fine-grained sand similar to modern dune sand (Farrand 1979:373). These aeolian deposits derived from marine beaches near the cave. Two "slumping events" at the cave in this lower sequence, after the deposition of Tabun G and near the end of the deposition of Tabun F, were probably caused by a lowering of the water table and the retreat of the sea (Farrand 1979:373; Bar-Yosef 1992:200). The groundwater table had to have been high during Tabun G in order to support the sediments that collapsed in subsequent periods (Farrand 1979:373).

The upper section of layer E, classified as Acheulo-Yabrudian, is composed of aeolian silt deposits, whereas layer D sediments, associated with Tabun D Mousterian industries, look more like loess (Farrand 1979:376). This suggests that the marine beaches were farther away during these periods because of a lowered sea level, and only the smaller particles could be transported by the wind to Tabun.

The pollen recovered from Tabun D layers shows an increase in tree pollen indicative of a wetter climate (Jelinek et al. 1973:159). There is also evidence in the upper beds of Tabun D for channelling and slumping into an inner cavity, also indicating increased moisture (Farrand 1979:376).

A hiatus occurs between layer D and layer C Middle Paleolithic deposits. Layer C deposits are characterized by terra rossa clays and limestone blocks from a collapse of the chamber roof and subsequent erosion from above the site. Farrand (1979) does not attribute this change from D to C layers as being due to differences in climate at the time of the deposition of Tabun C beds, but to climatic change that began earlier, possibly during the hiatus between D and C levels.

Mid-layer D appears to have been deposited during the wettest conditions, with dry conditions prevailing both before and after this period (Jelinek 1992). However, there was also a relatively moister period in layer E. Deposition was rapid in layer E, slower in layer D, and very rapid in layer C. Layer E was deposited during a high sea stand, layer D when the sea was receding, and layer C/B when the sea was quite distant. The four periods of karstic collapse between layer F and layer D may reflect lower levels of groundwater, suggesting a corresponding sea retreat and therefore more variability in sea level than is reflected in the sediments.

Sediments from Qafzeh (Farrand 1979) suggest a sequence of moister and dryer periods through the Middle Paleolithic sequence at this site, characterized by overall cold environmental conditions. The terrace deposits show evidence of rapid deposition. The cave deposits demonstrate dry conditions in beds XXI–XXIV, more moist conditions in beds XVII–XX, a return to dry conditions in beds XI–XVI, and moist conditions again in beds VII–X.

Pollen

The most complete pollen sequences from Middle Paleolithic sites in the Levant come from Tabun Cave on Mount Carmel in Israel (Horowitz 1979) and Nahr Ibrahim in south Lebanon (Leroi-Gourhan 1980).

At Tabun, arboreal pollen recovered from the lower levels of layer E (Acheulo-Yabrudian) suggest a warm climate, while those from the top of layer E (unit XI) suggest a cooler climate. Layer D samples show little change from those in the top of layer E, but layer C deposits suggest a more Mediterranean (warmer) climate.

Table 3. TL dates at Tabun (Jelinek 1982:1371).

Unit	Jelinek's Bed	Garrod's Layer	No. of Flints Dated	Age (× 1,000 yrs)*
I	17–26	C	7	171 ± 17
II	27–32	D/C	3	212 ± 22
V	41–42	D/C	4	244 ± 28
IX	62–69	D	3	263 ± 27
X	70–72	Ea–D	2	270 ± 22
XI	73–77	Eb–Ea	10	306 ± 33
XII	78–80	Ec(?)–Eb	4	350 ± 33
XIII	81–85	Ed	4	331 ± 30

* The error accompanying each age is the mean standard error for individual flint ages.

Non-arboreal pollen such as grasses and sedges were apparently lumped together and provide no strong indication for a wet environment in the immediate vicinity of the site (Jelinek 1981). A comparison of arboreal to non-arboreal pollen shows little change through the sequence, with arboreal pollen never being very plentiful and probable steppic conditions existing around the site during the formation of the "Mugharan Tradition" through Tabun C sequence.

The Nahr Ibrahim pollen samples apparently were all collected in the Central Chamber containing Tabun C-like Middle Paleolithic stone tools. These samples show an alternating sequence from cool, moist, forest types to dry steppic conditions and back again several times (Leroi-Gourhan 1980). Where this correlates with the isotope stage sequence is anyone's guess. However, ice cores from central Greenland suggest a rapid series of fluctuations in climate during isotope stage 3, from ca 60,000 to 25,000 BP (Boulton 1993; Kerr 1993), and major climatic shifts were associated with isotope stage 5 (ca 73,000 to 127,000 BP) as well.

Microfauna

Microfaunal remains, especially those of Rodentia, suggest some variability in the presence of certain warm- versus cold-adapted genera. Qafzeh contains two genera, *Mastomys* and *Arvicanthis*, found at Tabun in layer E (late Acheulian) and at Qumm Qatafa (late Acheulian), which has led some researchers to suggest an earlier date for these deposits (Bar-Yosef and Vandemeersch 1981; Tchernov 1981; however, see Jelinek 1981 for a different view). Other genera present at Tabun during the Mugharan through early Mousterian layers are absent from the Qafzeh deposits. In addition, both Hayonim Cave and Kebara contain rodents absent from Qafzeh. Given the close proximity of all these sites, Tchernov (1981) concluded that the Qafzeh deposits must have been deposited during different environmental conditions than other Middle Paleolithic sites in the region and that the site must be older than these other sites. Given the recent ESR dates at Tabun, this was apparently not the case, and in fact the Qafzeh deposits may be younger than those from Tabun (Mercier et al. 1995).

Jelinek (1981, 1992), having doubted Qafzeh's older age, has argued that the immediate environment around Qafzeh must have been different enough to allow these warm-adapted genera to exist near the site in a refugium, where they were preyed upon by raptors nesting in the cave, although they had disappeared from other areas just a short distance away. Jelinek (1992) argues that *Masomys* and *Arvicanthis* (along with *Gerbillus*) were warm adapted and could have migrated up the rift valley to Qafzeh while being unable to colonize the coastal environments of the Levant owing to unfavorable conditions.

Micromammal evidence from Douara Cave in Syria indicates dry conditions during both the early, Tabun D-like industries, and the later, Tabun C-like industries, occupations. The presence of xerophylic genera such as *Meriones* demonstrates a good deal of variability among these site locations during approximately the same time periods. It is clear that utilizing rodent remains to identify specific time placement can be problematical, as some sites such as Oumm Qatafa contain both warm- and cold-adapted genera.

TL and ESR Dates

Absolute TL and ESR dates have been obtained for Skhul (Stringer et al. 1989), Qafzeh (Schwarcz et al. 1988; Valladas et al. 1988), Kebara (Schwarcz et al. 1989), Quneitra (Ziaei et al. 1990), and Tabun (Grun et al. 1991; Mercier et al. 1995). Initial results demonstrate older ages for sites like Tabun than those suggested by the environmental evidence (Table 3).

The initial TL and ESR dates for Qafzeh of 92,000 and 98,000 BP and TL dates at Kebara of ca. 60,000 BP were earth-shattering when first presented (Lindly and Clark 1990a). These dates were much earlier than suspected and raised the issue of the relationship of archaic and anatomically modern Homo sapiens in this region.

More recently, the TL dates from Jelinek's excavation at Tabun pushed back the time frame for the Middle Paleolithic in the Levant by over 100,000 years

(Mercier et al. 1995). The layers in unit I known as Tabun C Late Mousterian are dated to 171 ± 17 ky BP and layers Ed to D (Mugharan Tradition to Tabun D Early Mousterian) are dated between 330 and 210 ky BP. With a Tabun C-like industry at Qafzeh at 90 ky BP and one at Tabun at 171 ky BP, this suggests either an extended reliance on this particular reduction strategy or the need to reexamine the later dates at Qafzeh (Mercier et al. 1995:507).

In addition, the presence of a Neanderthal at Kebara at c. 60 ky BP and one at Tabun I at c. 171 ky BP has caused some investigators to question what level the fossil remains should be assigned to at Tabun, layer C or layer B, and has led to new interpretations of the possible morphological differences between these two skeletons (Mercier et al. 1995). It is not clear that reassigning the Tabun skeleton to layer B would actually make the two specimens closer in time as there appears to have been very little spatial separation of B and C. However, it is interesting to note that if the Tabun C dates coincided with the Kebara dates then the morphological differences between the fossils in these sites would probably not have been in question.

The recently established dates for Tabun also present interesting problems to those scholars who argue for a late appearance for Neanderthals in the Levant (e.g., Bar-Yosef et al. 1992; Bar-Yosef and Meignen 1992): the Tabun C Neanderthals (and possibly Tabun D levels as well) are now as old or older than most dates from sites containing Neanderthal remains in Europe (e.g., Biache-Saint-Vaast, at 200,000–250,000 BP) and, more importantly, appear to antedate the anatomically modern remains at both Skhul and Qafzeh.

Summary

The Levantine dates demonstrate that the Mousterian, however defined, extends well back into the Middle Pleistocene in the Levant. These dates have ramifications for our interpretations of the Middle Paleolithic in this region and throughout Southwest Asia.

The relationship among the different Mousterian lithic industries in the Levant becomes even more muddled. For example, the duration of some of these industries is on the order of at least 80,000 years (Tabun C-type at Tabun 171 ky to Qafzeh at 92 ky). The lack of change in reduction strategy is difficult to explain if viewed in terms of the changing environment as documented by isotope stage 6 through 4 when the environment shifts from cold to warm and back to cold again. The perseverance of Tabun D-type industries from Boker Tachtit in the Negev of Israel at >47 ky to Tabun at ca. 263 ky also suggests a longevity of this technology not heretofore suspected. The Zagros Mousterian industries could well be as long-lived.

In addition, the relationship between the variously defined *Homo sapiens* found at these sites is even more difficult to explain. There were so-called Neanderthals at Tabun in layer C at 171 ky and at Kebara at 60 ky, while there were so-called anatomically modern humans at Qafzeh and Skhul at 80 to 100 ky. Given this evidence, the argument for no genetic admixture between these supposedly separate populations becomes even more difficult to sustain (Clark and Lindly 1989a, 1989b; Lindly and Clark 1990a).

The Levantine dates suggest that the age of the Mousterian in the Levant is comparable to that of other areas of the Old World. The ESR and TL dates from Karain and the thorium/uranium date from Houmian tend to corroborate this for the Zagros/Taurus region.

The fauna, pollen, and sedimentology of Zagros Mousterian sites paint a picture of cold and possibly moist conditions during the deposition of these layers beginning at 45–50 ky ago. With few clear absolute dates for Middle Paleolithic sites in the Zagros, except for these few radiocarbon dates at the top (most recent part) of the sequence, we cannot say for certain how far back in time these deposits were created. Dates from Houmian in the Zagros and Karain in the Taurus suggest occupation at least as far back as 110,000 to 140,000 years ago. However, it should not come as too much of a surprise if the Middle Paleolithic in the Zagros is even older and is more or less contemporaneous with the Mousterian of the Levant.

The lithic assemblages examined here can only be understood in these environmental and chronological contexts. As coarse-grained as they are, these data lay the groundwork for interpretations of technological organization that can be compared to surrounding areas in order to begin to document regional patterns of stone tool manufacture and use.

The Zagros Mousterian is unique because of the elevation of these sites, and the lithic assemblages recovered from these sites can be studied from the perspective of high-altitude adaptations of both animals and humans in Southwest Asia.

5

The Ecology of High-Altitude Adaptations

McBurney (1970) suggested that the sites in uplands of the Zagros region were high-altitude, limited activity locations. This seasonal pattern of land use by human populations appears to be a long-lived and variable practice in highland areas of Southwest Asia (Henry 1994). An investigation of how present-day humans and animals live in similar environments strengthens this viewpoint and suggests that McBurney was correct in his assessment.

Contemporary Nomadic Settlement Patterns in Southwest Asia

In some areas of Southwest Asia there are, or were in the recent past, populations who moved about the landscape seasonally. These peoples had economies based on pastoralism of sheep, goats, and/or camels. Their movements were determined by their own needs and the needs of their animals. This transhumance is a type of nomadism which exists currently in areas of varied environment and elevation conditions marked by marked seasonality (Henry 1984). The following are descriptions of when and why these people moved and some characteristics of the camps they made and used during each season.

Al Murrah Bedouin

The Al Murrah Bedouin of the Empty Quarter of Saudi Arabia divide their herding year into several periods, with two large-scale migrations that vary in the time of the year and are dependent on water and grazing conditions (Cole 1975:39–53).

Autumn is characterized by low temperatures and a lessened need for water by both Bedouin and their animals. At this time small groups disperse over the landscape moving frequently to search for pasture and then waiting for the winter rains. Group size is lowest during this period, site size is very small, and site locations are not used systematically.

The winter rainy season is characterized by a long-distance move to winter pastures from fall grazing areas. The location of winter pastures appears to vary depending on the quality of grazing available in an area; elevation does not appear to be a factor in the location of base camps. Once good grazing is found the lineage groups move approximately every two weeks to undisturbed pasture. Group sizes are relatively large and some aggregation occurs, with very little reoccupation of specific locations.

In the spring, groups disperse as pasture and water become scarce and the population begins moving toward the summer camps. Site locations are ephemeral and tend to concentrate around relatively permanent water sources such as wells.

Summer camps are also located around permanent wells and several groups may share a location. The summer site is a reused, permanent location and the Bedu remain for approximately three months. Water (and, related to this, good grass) is the primary factor affecting site location during this season.

In sum, the Al Murrah Bedouin settlement pattern is characterized by large sites during the summer and winter and very small sites during the fall and spring. Elevation does not control seasonality, although latitude appears to be a factor, with long-distance movement north in winter to seasonally available pastures. The large summer encampment might be a relatively recent phenomenon with the introduction of government wells, and I suspect that prehistoric settlement patterns during this season would have been very similar to fall and spring—i.e., small and ephemeral.

Oman Bedouin

Bedouin Groups of Oman have a winter-summer pattern of movement which consists of two systems (Wilkinson 1977:52–54). In areas with seasonal wells, the Bedu settle nearby in winter and in the upland zone in summer. In both seasons the availability of water conditions site location, and groups are relatively aggregated for most of the year. Site size appears to be about the same during both seasons. In the past, before wells were dug, the pattern would more than likely have been one of aggregation if relatively permanent water was available and dispersal when it was not (see below).

The second pattern, which occurs primarily in western Oman, is one of winter aggregation near water and summer dispersal to sandy areas that retain water. Group size and site area are large in winter and small in summer. Mobility is low in winter and high in summer.

Negev Bedouin

The Bedouin of the Negev desert, although now dependent on cultivated crops, still move seasonally to

find pasture for their flocks (Marx 1967:83–86). Winter camps are located at lower elevations, sometimes in a hollow in the ground for protection from the elements. Summer camps are located higher up to take advantage of breezes during the heat of the day. These are relatively permanent, large, long-term camps. In the spring, the Bedouin are more dispersed as they search for pasture during an east-west migration. Early summer sites are located in hilly areas, as these locations are the last to dry up and decent pasture is available until May. The Negev Bedouin settlement pattern and resource scheduling has been significantly altered by the introduction of cultivation, but regularities in the seasonal movement of the groups remain. Today the winter and summer camps are located near agricultural fields. In the past, the location of these camps would have been based on grazing conditions, which in turn are influenced by variable rainfall in the spring and early summer. Dispersed groups characterize the spring-summer pattern. The winter pattern might be characterized by more aggregation and larger sites when rainfall is abundant.

Rwala Bedouin

The Rwala Bedouin of northern Arabia (present-day Syria and Jordan) aggregated in the lowlands during the summer because water was abundant there; they dispersed during the winter and spring to the plateaus because of better pasture and water conditions (Musil 1928:164–165). We can assume that summer locations were large and possibly reused and winter locations were small and ephemeral. The cause of this apparently anomalous settlement pattern is unclear and remains unexplained by data from the historical accounts. *Water clearly is the limiting factor for settlement location,* and it is possible that the rivers in the Rwala region tethered summer occupation to the lowlands.

Basseri

In southern Persia (present-day Iran) the Basseri tribe has a characteristic pattern of transhumance with winter and spring settlement occurring at low to medium altitudes, summer settlement occurring at high altitudes, and autumn settlement occurring wherever pasturage (generally poor during this season) can be found (Barth 1964:4). Winter and summer camps are relatively more permanent than fall and spring locations, but group size is smaller, with populations dispersed in winter and somewhat dispersed in summer, suggesting that these latter locations would be smaller and more ephemeral than the larger spring and fall camps. This pattern contrasts markedly with prehistoric settlement pattern models proposed for prehistoric Levantine groups (Coinman et al. 1986; Henry 1994; Marks and Freidel 1977). The major difference is the ephemeral, dispersed settlement of the lowlands during the winter and relatively greater amount of aggregation in the highlands during the summer. Perhaps the occupation of the lowlands by agriculturalists causes the Basseri to disperse owing to a lack of decent pasture. The aggregation which occurs in the summer is harder to explain but must be related to the good water and pasture generally available in the summer range.

Baktyari

Cooper (1925) noted that the Baktyari begin moving their herds to summer pasture in May when the grass begins to "dry up" in the lowland winter range. The tribes stay in the upland valleys for four to five months, until the cold kills the grass, and then they return to the lowland camp to await the winter rains. During his journey, Cooper documented that it took the Baktyari, on foot, 26 days to move between their lowland winter grazing camps and their upland summer grazing camps (Cooper 1925). He describes these upland valleys as areas of "rippled silver streams feeding luxuriant young grass." Again, it appears that population aggregation occurs during the winter months in the lowland areas with relative dispersal of groups during the summer season.

Qashqa'i (Kashkai)

The Kashkai are nomads living in a territory close to the Persian Gulf in Iran who camp in the lowlands (averaging 630 m in elevation) in winter and in the highlands (2000 to 2650 m in elevation) during the summer. They have been studied several times in the past 40 years but the patterns of seasonal movement have remained the same.

Ullens de Schooten (1956) noted that the heat of the encroaching summer season motivates their movement to the uplands, usually in April. The lowland camps are located along the banks of the river Mound. The summer camps are located in upland valleys near springs or streams. Unfortunately, camp size for either season is not noted, but given that the Kashkai were migrating to the uplands with their herds (comprising upwards of seven million animals), it follows that these ungulates must be dispersed throughout the mountain zone and that group size and camp size would be smaller in the summer.

Beck (1991) made a more detailed study of the Qashqa'i who still live in the Zagros foothills above the coastal plains of the Persian Gulf during the winter and in the mountains during the summer. She documented it takes them three months in autumn to travel from the summer pasture in the Zagros Mountains to these winter pastures near the Gulf. This autumn migration is more arduous than the spring migration because there is no fresh vegetation for the sheep and goats to eat. The autumn migration is also difficult owing to the lack of water. Only permanent wells, a few springs, and some permanent streams have water in them at this time of the year, before the winter rains. In addition, winds and blowing dust are common during this time. During the

autumn migration, the same locations are reused as camps for many years (Beck 1991:32).

Lowland winter campsites are located in protected areas such as deep ravines, away from rain and cold (Beck 1991:78). The winter tents are of heavy-duty construction and the area around the tent is made to withstand the weather. Autumn and spring campsites at the winter pastures are placed in less protected locations, being more out in the open and composed of more ephemeral structures. There is less need for protection from the elements during these milder seasonal periods at the winter pastures.

Spring migration to upland summer pastures is easier for the Qashqa'i owing to an abundance of water and fresh vegetation. Again, old campsites are reused along the trail but many are in different locations than those used during the autumn migration, being specific to the spring migration.

In winter pastures family groups were aggregated, but in summer groups they were more dispersed owing to a shortage of pasture in the mountain valleys. Summer camps are moved several times during the three-month season in the highlands. Campsites are located based on nearness to water and to suitable pastures.

Afghan Pastoralists

The central Asian Arab pastoralists of Afghanistan also have a settlement pattern characterized by a low-altitude winter occupation and a high-altitude summer occupation (Barfield 1981:27–29). The winter is spent in the low river valleys at a single large camp; spring camps are located on the steppe above the river valley, while summer is spent in the high mountains above the 2500 m level. It appears that there is some differentiation in group composition and size, with groups being more aggregated in winter and less so during other times of the year.

Jordanian Bedouin

Henry (1984) studied the nomadism of the pastoral nomads living in the Ras en Naqb–El Quweira region of southern Jordan and developed the transhumance model that he applied to archaeological settlement patterns of the region (see Chapter 6). Populations in these areas tend to move seasonally as resources become available in the various habitats within the elevation zones of the region.

Henry (1984:12) found that the transhumance pattern of the Bedouin in south Jordan has three seasonal components. These consist of late summer–early autumn settlement in the uplands (>1500 m in elevation), a winter occupation of the piedmont (1000–1300 m in elevation), and spring-early summer settlement in the lowlands (700–800 m in elevation). Environmental conditions affecting resource availability (primarily water and plant food) and temperature requirements for both humans and animals are the primary factors in this seasonal mobility.

In the late summer and early autumn the Bedouin pastoralists move to the highlands because of the availability of water from perennial springs and grazing plants in this zone for their livestock. Group size is small and settlement is tethered to areas around water sources.

The winter is the rainy season, and during this period of lower temperatures the Bedouin occupy the piedmont zone. The piedmont is attractive at this time because this zone receives most of the runoff of rain and snow and also because temperatures tend to be higher than in the uplands. Henry reports settlement density is highest during this time, with camps normally being twice to four times larger than at other times of the year. In addition, because the piedmont zone is a relatively small percentage of the land available for settlement, the locations of the winter camps tend to be reused year after year.

In the late spring and early summer small groups disperse in the lowlands to take advantage of the pasture available, although it is never readily abundant even in well watered years. Group size is small during this period and mobility is very high.

In sum, the data from the pastoralists in southern Jordan suggest that winter camps will be located in intermediate altitudes, will be larger, and will have higher population density than summer-fall or spring-summer camps. In addition, spring-summer camps will be located in the lowlands and summer-fall camps will be located in the uplands.

Summary of Nomadic Pastoralists

There are some regularities in settlement patterns among nomadic pastoralists of Southwest Asia (Table 4). Generally, in areas with high relief (other than southern Jordan) there is vertical movement, with winter camps being large and located in the lowlands and summer camps being small, ephemeral, and located in the highlands. The summer camps would consist of small groups that move frequently and rarely use the same location more than once. The anomalies of the Basseri of Persia and the Jordanian pastoralists, who have nearly the opposite pattern of aggregating in the highlands and dispersing into small groups in the lowlands (although at different seasons of the year), are difficult to explain. Movement is still vertical, but group size and mobility patterns within each season are different. Yet, two factors still control movement and site placement: water and/or temperature (Henry 1994:340).

The Zagros Mousterian sites studied here are all located between 750 and 1400 m asl, and if the same environmental stimuli for the movement patterns of human occupants existed in the past, namely, vertical movement, water, and temperature, it is safe to assume that these conditions also affected site placement during the Middle Paleolithic. If this was the case, we have strong evidence that the Zagros Mousterian sites were

Table 4. Settlement pattern data for nomadic groups in Southwest Asia.

Group	Winter	Spring	Summer
Bedouin	piedmont	lowlands	highlands
South Jordan	large groups	small groups	small groups
(Henry 1984)	low mobility	high mobility	moderate mobility
	reuse of sites	no site reuse	some site reuse
Al Murrah Bedu	large camp size	small camps	large camps
Saudi Arabia	moderate mobility	high mobility	no mobility
(Cole 1975)	seasonal pasture	around semipermanent wells	around permanent wells
Bedouin	aggregation	(data not available)	dispersal
Oman	near water		uplands
(Wilkinson 1977)	large groups		small groups
	sedentism		high mobility
Bedouin	aggregation	dispersal	dispersal, then aggregation
Negev, Israel	low areas	pasture areas	small, then large groups
(Marx 1977)	moderate-size groups	small groups	high, then low mobility
	no mobility	high mobility	
Rwala Bedouin	plateau	same as winter	lowlands
Syria and Jordan	dispersed		aggregated
(Musil 1928)	small camps		large camps
	high mobility		no mobility
Basserri	lowlands	low/medium areas	highlands
Persia	dispersed	aggregated	aggregated
(Barth 1964)	small camps	large camps	large camps
	high mobility	moderate mobility	moderate mobility
Arab Pastoral	lowlands	steppe	highlands
Afghanistan	aggregated	dispersed	dispersed
(Barfield 1981)	large camps	small camps	small camps
	no mobility	high mobility	high mobility

probably summer camps. If the Zagros populations were part of a carnivore guild (Stiner 1994), following ungulate prey, it would be interesting to examine the movements of these herd animals in mountainous environments as well. These same environmental conditions, coupled with and related to the availability of pasture, appear to control the movement of herbivores in the same environments.

Animal Ecology in Mountain Environments

Many large-bodied herbivores also tend to move vertically through the landscape, pushed by changes in the seasons in mountain habitats. The pattern of mobility that develops is the same as that of their modern human predators.

Ungulates

In some central Asian mountainous areas, ungulate species such as wild sheep and goats seasonally migrate from low altitudes in winter to high altitudes in summer. This is not necessarily always a set pattern of movement but appears to be broadly based on temperature and other environmental conditions. Stone sheep in British Columbia have a complex movement pattern, but the "sheep are loyal to their home ranges and return to them in the same season year after year" (Geist 1971; Schaller 1977). The variability in movement is related to unpredictably changing temperature and environmental conditions. For example, a late spring snowfall may delay the movement of a herd to higher-altitude summer pastures. Another aspect to be considered is the presence of thermoclines, wherein valleys experience a temperature inversion with warmer air trapping colder air on the valley floor. In these cases, ungulates move to an elevation within the warm air layer.

The movement of ungulates does not necessarily follow a strict summer/winter dichotomy as there is evidence of spring-time movement to the lowest elevations, winter in middle areas, and summer at highest areas (Schaller 1977:182). The distance covered between

these seasonal ranges can vary greatly. Some tahr in Asia only move approximately 1,000 m in elevation between summer and winter areas. Goral in Russia do not tend to move more than 2 km, and there are no shifts in seasonal ranges at all by these ungulates in the Himalayas except when forced by severe winters. Muskox can move up to 17 km or have overlapping summer and winter ranges. Saiga antelope can move 100–120 km per day and range over 20,000 km^2 in a seasonal round (Schaller 1977:183). Stone sheep have yearly home ranges that cover part of or an entire mountain, or approximately one to two square kilometers in total area (Geist 1971:78). Bighorn Rams in Alberta, Canada, have a similar home range to stone sheep (ibid.).

In every instance, the amount of movement by these ungulates in a yearly round is motivated by the never-ending search for water and forage, which are controlled by seasonal or climatic conditions. In general, upland dwelling ungulates either remain in small, mid-altitude ranges or they migrate to higher elevations during the summer months. The latter pattern is the same as was documented for pastoralists in this environment. It would be safe to assume that hunter-gatherers living in these montane areas would also follow a similar pattern of movement by increasing either residential mobility or the distance traveled from a base camp in order to hunt on a daily or weekly basis. In addition, the procurement of meat would not necessarily have to be accomplished only through hunting. Ungulate natural mortality can be high during seasonal migrations, providing a ready supply of protein to be scavenged.

Ungulate Mortality

Mortality in mountain-dwelling ungulates can be caused by accidents, disease, predation, and seasonal stress. The causes of mortality vary based on the age and sex of the individual animal. For example, the age of death of bighorn rams in Canada is heavily biased towards older individuals. The older rams (>8 years of age) are 10 times more likely to die in a given season than younger adult rams (Geist 1971:295). Most of the rams that do not survive in the over-eight-year age bracket are dominant males that die because of the demands of the rut. Younger rams are excluded from the rut and therefore are not subjected to the stress, fighting, and lack of food as the older rams. Natural deaths can also be a result of falls from rocky ledges or avalanches. The younger individuals in a herd tend to fall more due to lack of experience on the steep slopes.

Disease has been documented in modern populations of mountain ungulates, but it is not clear how this can be extrapolated to the past (Schaller 1977:132). Most of the parasites, such as intestinal roundworm and lungworm, tend to debilitate the animal rather than kill them outright. However, in a weakened state the animal becomes more susceptible to predation or seasonal stress. Geist (1971:215) noted one large bighorn ram with heavy lungworm lesions that would have affected his ability to breathe and therefore to keep up with younger animals. This sheep had apparently slid down a slope and broke his neck and back. It is not clear if the disease was partially to blame in this instance.

Predation by carnivores is difficult to document in modern times in western Asia since many of these hunters have had their populations reduced to the point of having little impact on local ungulates. However, in the past there would have been a greater number of carnivores and these animals would have played more of a role in the mortality of the ungulate population.

The fox and jackal are primarily predators of small game such as rodents, birds, reptiles, and insects in high mountain regions of Nepal and Pakistan. Schaller (1977:138), however, noted ungulate remains in some fox droppings and suggests this represents food scavenged from either avalanche or large predator kills. Fox apparently can range to above 5,000 m in elevation and are found in nearly every habitat of these mountainous regions.

Wolves also occur throughout the upland areas of the Himalayas and mountains of northern Pakistan. Hunting in packs of two to five animals they prey on the ungulates available in the area, including domestic stock. No record has been made of wolves scavenging in this region but there are instances from areas of North America wherein carcasses were utilized at the beginning and end of the snow season (Stiner 1994:227).

The leopard and snow leopard both exist in the mountainous regions of Southwest Asia. Both are hunters but will scavenge if the opportunity presents itself (Schaller 1977:154). Leopards can have a definite impact on an ungulate population, accounting for as much as 13% of the deaths in local ungulate populations (Schaller 1977:134).

Hyenas apparently exist throughout Southwest Asia but are not currently very numerous. Data on hunting or scavenging behavior are not available for those animals living in a temperate environment. The data that exist come from studies done in arid regions of the Middle East and Africa. These data suggest striped hyenas in Israel and brown hyenas from southern Africa are "obligate scavengers," meaning they obtain most of their meat by a deliberate effort to locate carcasses rather than depend upon a fortuitous discovery (Stiner 1994:250). However, spotted hyenas from Africa tend to be both hunters and scavengers.

The brown bear in the Himalaya region exists primarily on plant foods but apparently also will eat ibex scavenged as avalanche victims (Schaller 1977:145). The Cantabrian Brown Bear regularly scavenges winter- or wolf-killed ungulate carcasses in the spring along the melting snow line as it eats the emerging grasses in the area (Clevenger 1991:42–43 in Stiner 1994:285). The proportion of carcasses scavenged is related to the amount of snow cover. Bears opportunistically take

advantage of carcasses becoming available along the snow line while grazing on new grass after winter hibernation. Scavenging is thus embedded in "normal" resource procurement.

In the past, hominids would have been part of the same large carnivore guild (Stiner 1994) as the bear, wolf, leopard, hyena, etc., and we might expect a reliance on similar, seasonally available meat resources. Modern pastoral groups kill wild ungulates during their spring and fall migrations in the Zagros region primarily because these animals follow similar migration routes (Beck 1991:50). Today these ungulates are hunted with rifles. In the past, it would have been more difficult to kill an animal using an intercept technique, as the terrain would be extremely difficult to negotiate. Using an ambush technique might have produced better results since mountain sheep and goats are very sensitive to danger below them but tend not to look upslope and can be approached closely from above (Schaller 1977:187). In addition, these animals tend to travel along well-used trails owing to the steep terrain, making their movements more predictable. This behavior pattern, coupled with the fact that when sensing danger the animals flee in mass and could be made to flee into a trap, would make an ambush approach more successful.

In sum, seasonal stress is probably the major cause of ungulate mortality, and the worst time for these animals is when they are moving from winter to summer grazing and become susceptible to "winter kill," an event that actually more often occurs in early spring when animals are debilitated by the winter. In addition, juvenile mortality is high after birthing in late winter/early spring. As mentioned above, the fall rut can be dangerous because of both accidental and violent injury, and it also can weaken the prime-age males to such an extent that they die. All of these causes of death among ungulates can provide scavenging opportunities for both carnivores and hominids. However, scavenging opportunities will be greatest during the spring in temperate or colder regions (Stiner 1994:286). The condition of the animals may be worse than in other seasons, especially for female ungulates with their low fat content and lean, almost "nutritionally barren meat" (Speth 1983:143). In these cases, scavengers may show a preference for males owing to their higher fat content.

Summary

How applicable are these studies of nomadic pastoralists with their flocks of sheep, goats, and camels to the study of prehistoric hunter-gatherers? Surely, these analogies cannot be too rigorously applied owing to assumed differences in economic organization and environmental conditions. However, when examined in more detail, the economies of present-day pastoralists and ancient hunter-gatherers are not so very different. Both are dependent on animals but the relations of production are different (Ingold 1980).

Pastoral nomads move about the landscape in order to position themselves and their animals with respect to water and grazing resources. Grass becomes all-important (Cooper 1925). The availability of these resources is dependent on rainfall which, in turn, is dependent on season and/or elevation. In other words, the plants that are the required grazing resource receive a geographically variable amount of rainfall. For example, Marx (1967) reports that in the Negev, good pasture becomes available and then dries up from east to west. A pastoralist has to make sure that his animals move to take advantage of the best available food resources.

Similarly, wild animals position themselves on the landscape to take advantage of the best resources. If good grazing is seasonally available in certain areas, then wild ungulates will migrate to this area on a yearly basis. In addition, water availability is a critical factor for animals that must drink on a daily basis. Put simply, wild ungulates must migrate based on resource availability just as domestic livestock must be herded based on these same limiting factors. It should follow that hunter-gatherers dependent, in part, on these animals and/or the plant resources they utilize, and restricted by the same environmental conditions, must move to take advantage of areas where resources are available. We might expect hunter-gatherer settlement patterns to be similar to nomadic pastoralist patterns in general where both types of economic organization are based on seasonal and vertical availability of resources (e.g., Henry 1994).

From these data, a model can be developed for Paleolithic hunter-gatherers. We would expect that hominid groups, living at least for part of the year in the Zagros region, would move vertically as a response to seasonal climatic variation. This movement would be characterized by a winter range in the lowlands and a summer range in the highlands. The ungulate populations in this region, migrating or moving in a similar pattern, could provide both hunted and scavenged resources. Scavenging would be most profitable in early spring and hunting at any time during the summer. If this is the case, it becomes clear that because the Zagros Mousterian sites discussed here are all upland locations they can be considered summer occupations of groups that were wintering at lower elevations. The upshot is that we are studying only one seasonal aspect of a much larger yearly settlement and subsistence system. Thus the summer system is the focus of this analysis.

6

Theoretical Basis for the Study

The history of approaches to the study of stone tools is the history of Paleolithic archaeology itself. From the beginning, stone artifacts constituted the bulk of what we studied to "know" what these ancient humans were all about. Lartet and Christy, de Mortillet, Bourlon, Henri-Martin, Breuil, and Peyrony, among others, grappled with the Paleolithic sequence in western Europe at the end of the nineteenth century and the beginning of the twentieth. The early approaches were strictly typological in nature, being based on French natural science research traditions. These scholars studied only the retouched stone and worked antler/bone from Paleolithic sites, often ignoring the numerically overwhelming debitage components. Tool types or *fossiles directeurs*, along with the type sites at which they were discovered, became the cornerstone for organizing the Paleolithic in space and time.

The typological approach was improved on by Bordes (1961a, 1961b), who retained a dependence on the notion that formal tools were ideal types that could be equated with identity-conscious social units. Bordes' major contribution was the identification of four main typological groupings of stone tools at Lower and Middle Paleolithic sites in western Europe and the establishment of a standardized typology that allowed the quantification of assemblages that could then be compared in a more objective way. His standardized typological list of 63 reoccurring tool forms can be converted into relative frequencies, cumulated, and compared statistically or graphically in a fixed order (Bordes 1961a, 1961b, 1972, 1977). Furthermore, assemblage differences and similarities were assessed using more than single type fossils; the entire tool component was examined along with the technology used to make the flakes and tools. The tool types proposed by Bordes were thought to represent a mental template of what a group thought each tool should look like and, implicitly, the identity or culture of Paleolithic people who made them.

Bordes' legacy lives on in current lithic studies with the *chaines opératoire* approach (Boeda 1988a, 1988b; Boeda et al. 1990; Turq 1992; see below). Although technology is more prominently considered in terms of selection, reduction, use, maintenance, and discard of raw material, this approach still retains the notions (1) that tools are desired end products, and the decision making involved and the type of core reduction utilized are primarily a function of the individual knapper's culture or social group, and, more importantly, (2) that these processes can be monitored by examining lithic assemblages.

Nevertheless, some Paleolithic scholars have realized that retouched tool types do not sort out as well in time and space as we have been led to believe (Straus 1987; Straus and Clark 1986; Straus and Heller 1988; Clark 1987; Clark and Lindly 1989a, 1989b; Lindly and Clark 1987, 1990a, 1990b). Further, the notions of type sites and sequences have no generalizable properties whatsoever for regional stone tool analysis. This is not to say that the typological groupings outlined by Bordes do not "exist" (see Callow and Webb 1981), only that their meaning is open to question.

The theoretical basis of the study of stone tool assemblages is admittedly in its infancy. The hows and whys we study what we do are weak. However, there are two primary approaches to organizing the analysis of Paleolithic chipped stone assemblages: land-use models and technology models. These are not and should not be considered mutually exclusive.

Land-Use Models

The study and interpretation of stone assemblages from sites created by hunter-gatherers is a critical aspect for understanding how these populations interfaced with their environments. Most land-use studies of this type have utilized heuristic models of settlement-subsistence strategies, the most prevalent being "foragers" and "collectors" (Binford 1980). In this case, the two strategies theoretically produce different types of sites and consequently different types of stone tool assemblages based on mobility, land use, and climate. However, these strategies are not mutually exclusive and are best viewed as a continuum, as it is possible for a group to be foragers for a season or even several years and then collectors when the environment imposes a change.

Other models of land use have also been based around variation in environment, climate, and elevation, which are then reflected in differential mobility, land use, and organization of lithic technology.

Binford's Model

Hunter-gatherer groups have two main types of movement patterns. Residential mobility refers to the movements of the entire group. Logistical mobility is movement by a subset of the main group who leave a base camp to procure particular resources.

Foragers are characterized by high residential mobility and low logistical mobility that, in effect, moves people to resources which are then processed for immediate use (Binford 1980). A forager strategy depends on locating resources during movement by the entire group. These systems tend to be located in a "generalized" resource environment where food, fuel, water, raw material, etc., are not "clumped" but spread "evenly" over the landscape. Sites created by foragers are ephemeral, with base camps being occupied for short periods of time and not necessarily year after year. Most ethnographically documented forager strategies can be ascribed to groups living in tropical and subtropical environments (Kelly 1983). However, the so-called cold-environment foragers move residential base camps to locations in the environment to place a group so it can take advantage of specific food species that are available during parts of the seasonal cycle (Binford 1980:17).

In contrast, collectors use low residential mobility but high logistical mobility to move resources to the main group in an environment characterized by an irregular resource distribution. Collectors can inhabit base camps for a season or a series of seasons, and locations can be used on a yearly basis although not necessarily for the same function (Binford 1982). Limited activity sites are created on the landscape where small groups procure specific resources and, in some cases, store them for future use. A collector strategy is most often used by hunter-gatherers in environments where resources are irregularly spaced and/or seasonal.

For Binford (1980), each of these strategies has expectations for stone tool assemblages. The technology utilized by a forager-type strategy is the expedient manufacture and use of generalized tools. Expedient tools are manufactured based on immediate need and are used for a specific purpose until no longer needed and then are discarded near the location of use. It is presumed that foragers can, if necessary, readily replace the stone tools that are utilized and disposed of as they move about the landscape.

This ideal scenario is based on the assumption that, along with food, fuel, water, etc., stone raw material will be spaced evenly about the landscape. Even given such an environment, however, foragers probably would curate at least some tools so as to not be left unprepared for any opportunity. For example, the Kung, the prototypical forager group, maintain (curate) tools for future contingencies in a manner similar to that of modern collectors (see below). In fact, if a group has high residential mobility, there should be more conservation and maintenance of tools owing to the unpredictability of both tool and raw material availability during these movements.

A collector strategy is argued to produce both a generalized technology and a specialized technology based on activities occurring at residential and logistical sites, respectively. Collectors make and maintain tools for future use by repairing and recycling them (Chatters 1987:341). The final discard location of these curated tools is normally not at the location of manufacture. However, it would seem imprudent not to consider that collectors would make and use expedient tools as well.

How to identify archaeological sites created by foragers versus those created by collectors has been a problem with the application of Binford's model (cf. Bamforth 1986; Barton 1990; Chatters 1987; Nelson 1991; Thomas 1983). The foundation for identifying collector-type base camps has been the assumption that they would be locations of a wide range of activities and therefore exhibit a diverse stone tool assemblage. Tools would be manufactured and sustained at the base camp, and, because of this, broken or exhausted tools that could no longer be used would be scrapped there as well. In contrast, collector field camps are assumed to be locations where special tasks or limited activities were performed, thereby creating chipped stone assemblages without much diversity where the primary lithic activity would be the maintenance of specialized tools and facilities.

If collectors, using a logistical strategy, would use specific places on the landscape for specific tasks, then we might expect artifact assemblages to unambiguously reflect this, so long as there is not a change in site function that could lead to the creation of functionally heterogeneous deposits. The problem becomes one of attempting to differentiate patterns of settlement at those sites that have had a variety of functions as base camps, hunting camps, and special activity sites through the years or millennia.

In contrast, foragers procuring resources as opportunities present themselves are expected to create places in the landscape with assemblages that are situational and, in general, more varied than those created by collectors. However, it is easy to see the problems of differentiating between a collector logistical camp location and a forager location where only a single resource was encountered and processed.

Theoretically, the forager-collector dichotomy is valuable in outlining potential hunter-gatherer land-use patterns that can then be used to reexamine archaeological data. In reality, this model can be very difficult to apply to archaeological data in a meaningful way.

In regions where Binford's land-use model has been applied to lithic data, it has been easier to look at degrees of mobility in terms of the number of expedient versus "formal" (curated) tools and the use of local versus nonlocal raw materials, rather than examine

settlement patterns in terms of collectors and foragers. In North America, the trend has been from formal tool use to expedient tool use as an area goes from a mobile lifestyle to a sedentary lifestyle (Andrefsky 1991; Parry and Kelly 1987). In addition, "exotic" raw material becomes increasingly rare in stone tool assemblages as populations become more sedentary and begin to depend more heavily on local raw material.

More recently, there has been a reinterpretation of the expectations of this model. Nelson (1991) has added the term "opportunistic technological behavior" as a response to unanticipated opportunities in an environment. Whereas expedient and curated strategies are planned technologies based on different conditions in an environment, opportunistic strategies are immediate technological responses to situations unanticipated by an individual or group. Again, the problem becomes one of identifying these strategies and associated behaviors archaeologically.

In addition, the term "curation" has come under attack either for being too broad, subsuming a variety of not necessarily similar behaviors (Odell 1996), or for meaning different things to different people, so as to have become meaningless as a heuristic device (Nash 1996; Shott 1996). It is clear that the term *curation* can no longer be used to describe all behaviors associated with the transport, conservation, maintenance, and reuse of stone tools. The behaviors associated with these activities have different implications for the organization of technology.

Odell (1996:74) suggests dividing what was called curation into two separate categories: (1) scarcity-induced economizing behavior and (2) curation, defined as the production of tools in advance of use, the design of tools for multiple uses, and the transport of stone from one location to another. Odell argues for these two categories based on the fact that each is a different response to human needs for tools. Curation is more closely related to the demands of mobility and settlement placement, whereas scarcity-induced economizing behavior is more related to the shortage of raw material. Although raw material shortages can be related to vagaries in settlement location and mobility, it is clear that a lack of suitable raw material can also be due to factors unrelated to both (e.g., Close 1996).

Shott (1996) suggests that curation should be defined in terms of the utility extracted from tools, not assemblages or industries. Curation is not, Shott (1996:264–265) argues, anticipation of use, transport, use life, recycling, or efficiency (in general). Shott's definition requires an initial measure of how much utility a tool has at the beginning of its use life (maximum utility) that then be compared with the utility that the tool has when it is discarded. The degree to which a tool has been used or the amount of utility extracted is the amount of curation that has occurred. Shott's definition suggests all tools (even expedient or opportunistic tools) are curated to some degree, as all tools are used. There are several problems with Shott's definition. First, as Shott acknowledges, measuring utility (degree of use) of stone tools is extremely difficult. How use can be separated from sharpening, resharpening, or breakage is not clear. How to measure the initial maximum utility of a tool is also a problem that cannot be easily dismissed. It seems that Shott's definition does not really resolve the problem of curation, but only replaces one set of poorly operationalized concepts with another.

For the data analysis presented here, curation will be defined as a means to extend the use life or utility of a tool, flake, or core through resharpening, transport, reuse, or recycling.

Marks and Freidel

In the Levant, Marks and Freidel (1977) have developed and applied a similar model, using data from Mortensen (1972), which distinguishes between radiating and circulating types of settlement patterns. A radiating pattern consists of one or two large sites or residential camps located near water or lithic sources surrounded by a series a smaller, special purpose or limited activity sites. In a radiating pattern, as with a collector strategy, residential mobility is low and logistical mobility is high. The lithic assemblages associated with this pattern are heterogeneous based on the different activities occurring at different sites across the landscape. A radiating settlement pattern has been proposed for the early Middle Paleolithic in the southern Levant.

A circulating pattern consists of many multipurpose sites, all of similar size, with similar artifact inventories. Residential mobility is high and there is little or no logistical mobility, as with a forager strategy (see above). The Late Middle Paleolithic (and Upper and Epipaleolithic) of the southern Levant is said to be characterized by a circulating settlement pattern.

The adoption of one or the other of these settlement patterns is said to be related to specific climatic conditions in the Negev region. A radiating pattern appears to be associated with a wet and warm Mediterranean type of climate while a circulating pattern was used in an Irano-Turanian desert type of environment that was both dryer and cooler. The dryer climatic conditions in the late Middle Paleolithic produced an environment that could not support large base camps so groups had to disperse and become more residentially mobile. Unfortunately, this model does not seem applicable to other areas of the Levant where climate, raw material availability, and site location and function were very different.

Henry's Model

Henry (1984, 1994) has developed another model for settlement-subsistence in the Levant utilizing data collected on Bedouin land use in modern and recent historical periods (see Chapter 5). This transhumance

model suggests a vertical pattern of movement that still exists today in montane areas with "patchy" environments and elevations characterized by marked seasonality. Populations in these areas move seasonally as resources become available in various habitats within the elevational zones of a region. This model suggests seasonal movement between the piedmont and the lowlands that affects group size, composition, and activity patterns and consequently expectations about the archaeological record. For the Middle, Upper, and Epipaleolithic the model predicts large, semipermanent winter sites in the piedmont, where groups would aggregate in residential base camps characterized by a diverse toolkit of expedient tools. In the summer these groups would disperse in the uplands, creating small, low-density, limited activity stations with specialized toolkits composed of formal (curated?) tools. The model is driven by the relative rainfall of each elevation. For example, the winter settlements are located in the piedmont because this area receives the maximum rainfall during this part of the year. This pattern shifted in the Chalcolithic period (5.5 to 6 ky) to winter aggregation in the uplands and summer dispersal in the lowlands owing to an environmental change to warmer and dryer conditions in the Holocene that continues today. During the Pleistocene, the uplands would only have been available to local groups during the warmer months. In the Holocene, the uplands could be exploited during most of the year.

Archaeologically, the model appears to fit data in areas of the Levant with high relief, as most large sites are located in the lowlands and smaller sites are found in the upland areas. The key determinants for the model are temperature and water. Groups will move to the elevation that provides the most predictable water for that particular season if the temperature allows.

Coinman and Colleagues' Study

A test of these models developed for the Levant has compared elements of the forager/collector continuum, the radiating/ circulating model, and the transhumance model with data on Paleolithic sites in the Wadi el'Hasa, west-central Jordan (Coinman et al. 1986).

Coinman et al. (1986) discovered that the forager-collector dichotomy of Binford (1980) could not be tested with the available data from Jordan. However, several of the drainages in the Wadi el'Hasa have settlement data that appear to fit Binford's collector model of a few large sites surrounded by a series of much smaller sites in the Middle Paleolithic and Pre-Pottery Neolithic periods. Of course, owing to the similarity of the models, these data fit Marks and Freidel's (1977) radiating pattern as well. In addition, one of the drainages has settlement evidence for a foraging/circulating pattern during the Epipaleolithic/ Pre-Pottery Neolithic with small, undifferentiated sites at several elevations.

Henry's (1984) transhumance model, as it was developed for south Jordan, did not appear to fit well with the data from the Wadi el'Hasa. The reasons for this lack of fit were not clear, but perhaps the scales of environmental contrasts in each region were different. There were several very large sites in the uplands of the Wadi el'Hasa along with smaller sites during the Middle and Upper Paleolithic, suggesting either repeated reuse of a location or the presence of both base camps and limited activity locations in the same elevational zone. Of course, given the extremely long time periods we are studying, it is possible we are combining seasons and/or time periods.

With better knowledge of the sites in this region, along with more information about seasonal water, temperature, and paleoenvironment characteristics of the Wadi el'Hasa, the models might be more accurately tested.

The Effects of Mobility on Technology

As outlined above, the forager-collector continuum has specific expectations regarding technology. Expedient technologies "comprise tools that are manufactured, used and discarded according to the needs of the moment" while curated technologies "comprise tools that are effective for a variety of tasks, are manufactured in anticipation of use, maintained through a number of uses, transported from locality to locality for these uses and recycled to other tasks when no longer useful for their primary purposes" (Bamforth 1986:38). To this we can add opportunistic strategies which are an immediate technological response to unanticipated conditions (Nelson 1991:65). How expedient and opportunistic strategies and the associated stone tools could be distinguished from one another is not clear. Binford (1980) associates curation with collector strategies and expediency with forager strategies. Bamforth (1986) and others (e.g., Shott 1996) do not, viewing curation more as a response to raw material scarcity and differences in mobility strategies or as a means to prolong the utility of a tool than as being applicable to a general definition of collectors. Nelson (1991) sees these technological strategies as being more flexible and not attributable to any one set of circumstances or behavioral set of variables. However, there are a few expectations regarding these technological solutions. First, by their nature, curated technologies should produce lithic assemblages that are morphologically complex and distinct. Expedient (and opportunistic) technologies should produce assemblages that are morphologically simple and homogeneous. As with the forager-collector continuum, curation, expediency, and opportunistic behavior should also be viewed not as mutually exclusive but more as variable technological solutions to changing environmental requirements.

How stone tools were made and maintained, how

they were carried around an environment, and where and why they were discarded can provide information about how a population solved problems of overall stone tool needs with raw material availability. Three basic problems must be solved for a mobile population to produce the tools that they need: how and when raw material is obtained; where raw material can be found in a region; and how the collection of raw material and the production, use, and maintenance of tools is accommodated into a "mobile lifestyle" (Kuhn 1994).

The timing of tool manufacture is also important in areas where there is unreliable resource availability. Torrence (1983, 1989) has suggested that curation (tool manufacture in anticipation of future use) will alleviate the problem of time stress associated with the scheduling of resource availability and will provide the need for tool production well in advance of when they will be used. Torrence suggests that time stress can be documented in stone tool assemblages by distinguishing the proportion of complex versus simple tools and facilities, the number of functionally distinct types in an assemblage, and the ratio of curated to expedient tools. The more complex and curated tools there are in an assemblage, the more time stress there is on the population who made them.

In an environment where there is not enough time for both resource procurement and tool manufacture, populations must anticipate the need for tools (Kuhn 1995). However, it would be naive to assume that any stone-tool-using group would not anticipate using these tools every day, at least at some level. Any chance to acquire a resource that is unsuccessful because of the absence of the correct tool can severely endanger the survival of any group. Foreseeing the need for tools can be achieved at two levels: the needs of an individual and the needs of a place (Kuhn 1992a). Individuals must utilize technology that provides "flexible, multi-purpose gear" made to handle any future requirements that may present themselves. Again, however, it is reasonable to assume that all stone-tool-using individuals provision themselves to some degree with stone in anticipation of future use. In contrast, the provisioning of a location with the raw material and/or the flakes/tools essential to complete a particular task would be supplying a place. Archaeologically it could be difficult to distinguish the artifacts at such a place as "transported" unless the location of the raw material source is unambiguously known. In addition, the return to a place on the landscape repeatedly would create a kind of "source" for raw material, and populations would be "provisioning a place" without consciously attempting to do so.

Kuhn (1992a) suggests that the occurrence of heavily retouched or resharpened tools and small, "exhausted" cores made of nonlocal raw material implies the long-distance transport and discard of curated items (see also Binford 1979; Gramley 1980). This would be an example of provisioning individuals. An emphasis on individuals would be manifest by evidence for the manufacture and reconditioning of tools. These activities are normally documented ethnographically at residential "base camps" during periods when there are no procurement activities, although it is not clear why this would necessarily be true all the time. Manufacturing or reconditioning at least some tools probably occurred during any period of the year and during any activity, as they were required.

In contrast, the presence of unworked raw material, large cores, or large flake blanks that have been transported from far away suggests the provisioning of a place.

Another aspect affecting tool maintenance and resharpening is *raw material availability*, with some arguing that this may be the most important element affecting the organization of lithic technology (e.g., Andrefsky 1994). As noted above, if raw material is plentiful in an area, it may be more efficient for a tool user to discard an exhausted tool and make or pick up another flake than it would be to resharpen the one in use. If there is an abundance of raw material, then there is very little need to transport and maintain tools while moving from place to place. Bamforth (1986, 1991) argues that curation is primarily due to the scarcity of raw material in an environment. This scarcity can be related to the absence of usable stone in the environment, to settlement-subsistence patterns that do not permit easy access to raw material, or to scheduling problems (Torrence 1983). One of the expectations of this lack of raw material would be that cores would be utilized to a greater extent, leading to smaller core sizes but also to smaller flake sizes. In addition, the number of flakes produced would increase, leading to larger flake-to-core ratios (Dibble 1995b:292), assuming there is no transport of flakes to or out of sites.

High residential mobility constrains how much raw material can be carried across the landscape. All prehistoric hunter-gatherer populations must have carried some stone with them, in the form of flakes, tools, or cores. It is what this mobile toolkit consisted of that varies. Bifaces were carried and used by Paleoindian groups in western North America to deal with high mobility (Kelly 1988; Kelly and Todd 1988). Highly mobile Australian Aborigines and Nunamuit Eskimo appear to transport either very little or a great deal, respectively, as they move across the landscape (Kuhn 1994:427). The differences between these two groups are probably related more to the fact that the Nunamuit use sleds and can physically accommodate more things, but in the past these differences, on a lesser scale, could have been due to raw material variability, time stress, and/or the seasonality of their respective environments. Simply put, raw material must be available, either through transport or natural occurrence in the environment, at the location where it is needed. In areas with no sources of raw materiel, all the stone used must be carried in from elsewhere (e.g., Close 1996).

This mobile toolkit is defined as "artifacts that mobile individuals keep with them most or all of the time, implements that are subject to virtually continuous transport" (Kuhn 1994:427). This "personal gear" (Binford 1979) would be utilized by an individual to solve problems of raw material variability and scheduling that can occur in any environment.

The objective of the toolkits used by mobile populations is "to minimize the risk of being caught without serviceable tool edges" (Kuhn 1994:428). However, as mentioned above, populations are limited as to what they can carry. Ebert (1979) suggests that tools or cores in a mobile toolkit will be smaller than those made and used in one place. Multipurpose tools will have had more energy invested in them than those tools used only once and hence will have more "value." It follows that any mobile toolkit should be composed of these small, multipurpose tools.

In order to examine the composition of a mobile toolkit, Kuhn (1994) developed a model based on tool size, transport costs, and potential utility, with all other things being equal. He proposed that the best *single* stone object to carry around a landscape would be a core. However, the best overall strategy for a mobile toolkit would be for numerous, "functionally specialized," smaller flake tools to be carried. In contrast, Morrow (1996) argued that Kuhn's (1994) calculations were incorrect and that large stone tools would better at maximizing utility and minimizing transport costs as required for all toolkits (however, see Kuhn 1996). Notwithstanding the debate over what mobile populations should carry around the landscape, the point is that most if not all recent and ancient hunter-gatherers would have needed to carry tools or cores around the environment. Landscape models attempt to understand these strategies by reconstructing the regional organization of lithic assemblages through the application and development of models of subsistence and settlement. The manufacture of stone tools is embedded in the overall lifeways of the hunter-gatherers being studied. Learning the minutiae about core reduction at a site, by itself, does little to help us understand the process behind this behavior on a regional scale. Models of lithic technology, eschewing typology, should work from the perspective of the assemblage to regional models of technology that are then "fitted" to settlement and subsistence data. Unfortunately, most of these models have not progressed that far and typological perspectives are still with us in the disguised form of *chaîne opératoire*.

Technological Models

Landscape models explore such things as "the pattern of core reduction/blank production, tool resharpening, and the movement or displacement of raw materials" embedded in a regional perspective (Kuhn 1993:27). Technological models have tended to investigate assemblage variability from the perspective of core reduction, tool production, and tool reduction from a site-specific perspective that theoretically can be extrapolated to a region (Bar-Yosef et al. 1992; Dibble 1995b; Dibble and Rolland 1992; Rolland and Dibble 1990; Rolland 1977, 1981).

Chaîne opératoire

This "technological" approach uses the examination of the entire reduction process to investigate stone tool traditions or typologies. The study of *chaîne opératoire* (operational sequence) is the study of the "life" of a tool. It begins with the selection and testing of raw material, then proceeds through core decortification and shaping in order to produce a blank, on to tool manufacture, and finally use, maintenance, and discard (Boeda et al. 1990). The "choices" made by Paleolithic hominids at each stage of the reduction sequence are of primary interest in that they are believed to lead to the recognition of "technical traditions" (Bar-Yosef et al. 1992:511). In this way, a prehistoric social group could be identified by the dominant operational sequence used in blank/tool production. The ultimate goal in studying *chaîne opératoire* is to recognize these social groups.

The methodology of *chaîne opératoire* is one way to view stone tool manufacture and the creation of lithic assemblages. New World lithic analysts have been using a similar methodology for years (Collins 1975). However, the theoretical basis behind the *chaîne opératoire* approach, namely, a view that Paleolithic stone tools reflect culture, ethnicity, or traditions, is questionable. Social groups in the Paleolithic are notoriously difficult to identify, and stone tools are a particularly poor conductor of this information. It is more productive to examine the means of raw material acquisition, specific blank production, tool use, rejuvenation, etc., from the perspective of reduction.

These reduction approaches to technological analyses of raw material utilization have had some success in addressing assemblage variability. The following discussion will outline this approach in more detail.

Core Reduction

An analysis of core reduction is based on the fundamental fact that it is a process of subtraction: cores become smaller through the removal of flakes. From this, the size of the core, flake-to-core ratio, cortex percentage, and size of flake scars on the core can all be used to address raw material size and intensity of use. Stress on raw material would "force" a core to be used more than if raw material were plentiful, and thereby increase the number of flakes relative to cores. In addition, cores would be smaller, there would be less cortex remaining, and the range of flake sizes would be greater as the number of smaller blanks increased.

Tool Production

The selection of blanks to be made into tools can also provide information on raw material variability. If there was stress on raw material, more tools would have been made from a finite number of blanks, producing a higher tool-to-flake ratio. In addition, as more tools were manufactured, the size of available blanks would become smaller as would the size of the tools produced from them. Given these relationships, it should be possible, by studying the characteristics of a tool component at a site, to determine the degree of raw material availability. Again, however, the key would be to determine why there is raw material stress in the first place by examining other variables, such as size, scarcity, quality, level of mobility, etc.

Tool Reduction Model

Harold Dibble (1984a, 1987a, 1987b, 1995a; see also Barton 1988, 1990; Dibble and Rolland 1992; Holdaway et al. 1996; Rolland 1977, 1981; Rolland and Dibble 1990) has argued that certain scraper types recognized by the Bordes typology are actually the consequence of edge rejuvenation during the life of these tools. This scraper reduction model has been the basis for a new interpretation of Middle Paleolithic assemblage variability that discounts functional arguments and ethnic traditions (Dibble and Rolland 1992; Rolland and Dibble 1990). Scraper "types" are seen as stages produced as these tools are continuously resharpened rather than ideal shapes produced for a specific task or due to the "mental template" of distinct social groups. The reduction model differs significantly from the *chaîne opératoire* approach because of this view of the causes of scraper morphology.

The Bordes (1961a) typology identifies 25 scraper or scraper-like tool types. The most common are scrapers with retouch on a single edge, either parallel to the axis of flaking or perpendicular to the axis of flaking, labeled simple scrapers and transverse scrapers, respectively; and scrapers with retouch on two edges, either parallel to the axis of flaking or converging at the distal end, identified as double scrapers, convergent scrapers, dejeté scrapers, limaces, and Mousterian points. The scraper reduction model predicts two trajectories of resharpening: (1) single scrapers to transverse scrapers and (2) single to double to convergent or dejeté scrapers. The first trajectory has only one edge being reduced throughout the life of the tool while the second has two edges being reduced. It is important to note, however, that for this model, during both trajectories it is assumed that *only one edge at a time is being used and reduced.* This premise has important implications for the argument that convergent scrapers or Mousterian points were made to be pointed tools, either as projectiles or something else (Holdaway 1989; Kuhn 1989; Shea 1988, 1990; Solecki 1992; Solecki and Solecki 1993; see below). There are several expectations of the model that should be clarified:

First, tools can be resharpened to a minimum size before discard. This does not necessarily mean that every tool will be reduced to exactly the same size in every assemblage, only that where raw material is scarce and original blank size was relatively the same, there will be maximum reduction to a particular minimum size. What determines this minimum size can be related to practical considerations, such as the ability to hold a tool while working with it. Yet, this limit can also be related to the complex relationship among raw material size, availability, and quality; the energy needed to create a new tool; and a tool's perceived usefulness. In other words, this lower size limit should vary with each situation.

Second, the overall length of the blank does not have to decrease systematically after each resharpening stage. For example, the length of single, double, and convergent scrapers could be very much the same in a given assemblage since the emphasis is on the retouch of the lateral edges of these tools rather than on the distal end. Therefore, length is a poor measure of reduction (Dibble 1995a). In fact, Dibble has suggested that convergent types will be shorter than other scraper types *only in the most intensively utilized assemblages.* In addition, greater thickness within a scraper type does not necessarily suggest more reduction per se, only that the original blank size was larger (Dibble 1987a; however, see Mellars 1996:109). Dibble has argued that all scrapers should be larger, on average, than the unretouched flake component of the same assemblage because the original flake blanks chosen to be retouched will have been the largest available. This means the remaining unretouched flakes will be the smaller component of the assemblage.

In Dibble's (1995a) model the single, double, convergent sequence or the single to transverse sequence does not represent a consistent series of rejuvenations that every scraper goes through. Each of these types can ultimately be the final result of resharpening if it has reached the minimum size threshold precluding further resharpening. In this way, single scrapers do not always have to be the largest scrapers; rather, they can also simply be tools made on smaller blanks that have reached the minimum usable width through fewer resharpening events.

Dibble (1995a) suggests that flake blank shape (see also Barton 1990; Kuhn 1992b), retouch of the maximum edge length regardless of its orientation to the flake axis, and the occurrence of a backed edge will all produce exceptions that do not fit his scraper reduction model. In addition, raw material abundance and size could be added to this list of factors affecting how reduced an assemblage will be. Abundant raw material will usually allow knappers to discard tools more quickly as it is more convenient and efficient simply to make another

blank than to refurbish an existing tool. Small-size raw material, such as stream cobbles, might also influence how far blanks are reduced. In other words, one group's discard width for a tool may be just the beginning of a reduction sequence for another group.

Blank size and shape appear to be an important source of variability in scraper reduction. The choice of how a blank will be resharpened appears to be related to blank shape, with shorter and broader blanks associated with single-to-transverse trajectories and longer, narrower blanks with the single-to-double-and-convergent trajectory (Dibble 1987a, 1991; Kuhn 1992b; Mellars 1996:108).

Kuhn (1992b) suggests that double scrapers, convergent scrapers, and Mousterian points should be made on long blanks whereas transverse and dejeté scrapers should be made on wide-squat blanks, and there should be an inverse relationship between the types found in both sequences. In assemblages with long blanks there should be few transverse and dejeté scrapers, and, conversely, when there are short-squat blanks there should be few double- or convergent-edged pieces. This contrasts with Dibble's model because Kuhn lumps single-edged (transverse) and a double-edged (dejeté) scraper types together (see also Barton 1988). In this case, the shape of the original blank is more important than the number of edges retouched. Transverse scraper types should correlate inversely with double and convergent types. Single-edged scrapers, the initial stage for both sequences, are more problematical to assess. These scrapers could continue to be resharpened because it was necessary to do so, as in the case of blanks that are naturally backed along one edge. The cortex protection might force the initial edge to be used longer to continue to take advantage of the protecting "handle." Since almost half the sites that were found by Dibble (1995a: 340) to have a larger than expected number of single-edged scrapers are from the Zagros Mousterian, this study will investigate that possibility as well. Dibble (1995a) also submits that lightly reduced assemblages will have mostly single-edged scrapers because rejuvenation never proceeds past the early stages of resharpening. Yet, those assemblages that are heavily reduced are suggested to have a high number of single scrapers since singles would have been started on smaller blanks owing to raw material stress and would have reached minimum width before they could be made into more reduced types. The model does, however, predict that in heavily resharpened assemblages the proportion of single scraper types will "decrease" while the proportion of more reduced types will "increase." In one area of so-called heavily reduced assemblages, like the Zagros Mousterian, this process is examined more closely.

Nevertheless, the occurrence of exceptions to the predictions of Dibble's model does not negate its significance or importance for explaining at least some of the assemblage variability in Middle Paleolithic assemblages. The Zagros Mousterian is a perfect test of Dibble's model since these assemblages were made from the relatively small cobbles available in the region and utilized at sites that were remote and presumably intensively occupied for short periods of time. In fact, Dibble has already tested his model using material from the sites of Bisitun (Dibble 1984b) and Warwasi (Dibble and Holdaway 1993). In addition, material from the 1969 excavation at Kunji has been studied utilizing the scraper reduction model with less than satisfactory results (Baumler and Speth 1993; however, see Dibble 1995a for criticism of the model's application).

Along with scrapers, notches and denticulates have also been suggested to be part of a reduction continuum wherein the larger the blank, the more notches will be created on it as old notches become dull through use (Barton 1988, 1990; Holdaway et al. 1996). In other words, denticulates are the result of the resharpening of notched flakes. The smaller the blank, the smaller the number of notches that will be made on it, and therefore single notches (Bordes' type 42) will be on the smallest blanks. This model assumes that it is the individual notches that are the desired "tool" or functional edge rather than the denticulate, or series of notches. In addition, this behavior appears to vary based on the abundance of good-quality raw material. In areas with abundant raw material, new tool blanks would be selected rather than reuse of old, notched blanks. In this scenario, notched pieces would not be smaller than denticulates. There are also differences expected between fine-grained and coarse-grained raw material, with notches and denticulates usually manufactured on the latter.

In sum, there are several expectations inherent in the reduction model as it has been applied to Middle Paleolithic assemblages. First, the percentage of scrapers among retouched tools in an assemblage will be directly related to the number of overall tools found (Rolland 1977, 1981; Dibble and Rolland 1992). Second, scraper numbers can be used to assess the intensity of reduction in an assemblage by comparing the numbers of the most reduced types of scrapers (convergent and transverse types) and the least reduced types (single types). Finally, the percentage of scrapers should be positively correlated with the percentage of most reduced types and negatively correlated with the percentage of least reduced types.

Pointed Tools

The debate over the meaning of pointed implements in the Mousterian is important from the perspective of the reduction model presented above because it concerns the possibility of randomly versus purposefully retouched tools in these assemblages (Holdaway 1989; Shea 1988, 1990; Solecki 1992; Solecki and Solecki 1993). Yet, this should not be an either/or argument. It is not inconceivable that some pointed tools were made to

be pointed from the onset, rather than as a final stage in the resharpening process. As outlined previously in this chapter, blank shape can affect the final shape of a retouched tool. If a blank began with convergent edges, it is likely that the tool made on that blank will be convergent as well. This is not to suggest that these convergent-edged pieces were used as projectiles but only that a pointed tool might solve a problem that a straight-edged tool could not. Once the convergent-edged tool was created, it would have been repeatedly resharpened in this shape. This might partially explain why convergent-edged forms don't always conform to the expectations of Dibble's model (1995b). In these situations of convergent-edged blank to convergent-edged tool, the pieces may not have intensively retouched edges. In contrast, in situations where a rectangular blank was reduced to a point, the convergent-edged final stage will have a greater amount of retouch because more material has to be removed from the surface area of the original blank in order to get a pointed shape.

A more interesting question from the point of view of the reduction model is, Why should convergent pieces always be the potential end result of a series of resharpening events on elongated blanks, all other things being equal? Why wouldn't knappers simply continue to resharpen two parallel lateral edges to a minimum width, resulting in a plethora of double scrapers, with the end result being assemblages dominated by the "rods" found in some Zagros Mousterian and Baradostian assemblages (Akazawa 1975; Hole and Flannery 1967; McBurney 1964)? In attempting to address this question, Dibble (1995a:320) has suggested that "it is possible to increase the length of the working edge by cutting across the blank diagonally." In other words, convergent edges, to a certain point, are longer than those that follow the length of the blank and therefore give more working edge. If a longer edge was needed, then convergent-edged pieces would be the best solution. Yet, if longer edges were all that was wanted, then all scrapers would be made from the start with at least one diagonal edge, and straight-edged pieces, either single or double, should be rare. A parsimonious explanation might be related to the hafting of these tools. Hafting would keep the proximal or "butt-end" the same size as the working end is used and rejuvenated. The working end would be resharpened more intensively toward the distal end and less so as the edge approaches the haft. This process would, in effect, create convergent-edged tools every time, given a large enough blank. Other explanations are possible; thinner "rods" were more difficult to handle than convergent pieces with larger bases, or a thinner distal end of a blank would have experienced more attrition and needed more retouch to be useful.

The question of the genesis of convergent-edged scrapers/points aside, the question of the possible function of these tools remains (Bergman and Newcomer 1983; Holdaway 1989; Kuhn 1989; Shea 1988, 1990; Solecki 1992; Solecki and Solecki 1993). Some use-wear analyses seem to suggest that pointed tools, both blanks and retouched pieces, were used both for cutting and as projectiles (Shea 1989, 1993). The suggestion that these tools were used for cutting seems to be well accepted. On the other hand, the suggestion that they were projectile points hafted on to spears has provoked a healthy debate.

The main point of contention appears to be whether Levallois points or retouched Mousterian points/convergent scrapers show the damage patterns that one would expect if they were hurled at or thrust into a fleeing animal—i.e., impact fractures at the tip or the complete loss of the tip due to breakage. After examining the damage to tips of Levallois and Mousterian points and also comparing the number of proximal bases to distal tips at several sites, the consensus appears to be that they do not show this pattern of damage (Bergman and Newcomer 1983; Holdaway 1989; Kuhn 1989; however, compare with Shea 1988). Bergman and Newcomer (1983) saw evidence of tip damage consistent with assumed projectile points at Ksar Akil.

In addition, breakage patterns are different than one would expect had these tools been used as projectiles. Holdaway (1989) found no difference in the number of proximal fragments versus distal fragments for Mousterian points/convergent scrapers at the Zagros Mousterian sites of Warwasi and Bisitun. This contrasts with an expectation that, after being broken during a hunt, the proximal bases would have been brought back to these sites on the spear and removed in order for new points to be hafted back on. If these tools were hafted in a handle, however, any breakage would occur at the site and both sections of the tool would be discarded there.

Churchill (1993:16) found few ethnographic examples of handheld spears being thrown at prey. In most cases, spears are thrust into an animal that has been trapped, corralled, or slowed down long enough to employ this weapon.

In a related finding, Kuhn (1989) points out that the occurrence of these tool forms does not correlate with regions where populations would have had access to abundant animal prey, and where hunting would have been especially important. He also suggests that the overall morphology of these pointed tools, including a large, protruding bulb of percussion, would prevent them from being hafted very easily. However, Solecki and Solecki (1993) have documented the existence of "post-removal butt modification" during the Mousterian at Shanidar Cave that could be interpreted as a hafting modification. This occurred on 34 of the 381 pointed artifacts studied. At not quite 10% of the total pointed pieces, this is not an impressive amount of modification.

Bruce Howe (personal communication 1991) suggests that most Mousterian and Levallois points do not have the symmetry or balance to be successful projectiles. The robusticity of most of these points

precludes them from flying through the air without a serious destabilizing effect, which in turn would affect the accuracy of the projectile and the success of the hunt. However, a wooden thrusting lance tipped with a convergent-edged "point" would not have this problem.

In sum, the heavily reduced convergent-edged tools found in the Zagros Mousterian collections studied here provide an opportunity to examine this problem in greater detail. A lack of tip damage to these retouched tools would suggest that these pointed pieces were not thrust into animals either. In other words, these tools were not made to be pointed because they had to function as spear points and another explanation would be needed.

Levallois Technology

The Levallois technique was integral to the definition of the Middle Paleolithic/Mousterian from the initial studies of this material in France at the end of the nineteenth century. Recently, however, there has been a great deal of debate as to what exactly a Levallois technology is and how it can be identified in a Middle Paleolithic chipped stone assemblage (Dibble and Bar Yosef 1995; Van Peer 1992). In fact, the term has become so vague and its definition so varied that it has become virtually useless in a descriptive or technological sense. A conference held for the express purpose of defining Levallois technology could not accomplish that task (Dibble and Bar Yosef 1995). "Levallois method or technique" means different things to different people. The following will offer no solution to this problem but will review the subject in order to justify using this terminology here.

The original definition of Levallois was one of a predetermined flake being removed from a centripetally flaked core specifically prepared for that purpose. Later definitions had to come to terms with Levallois blades and points, and the fact that these very different methods of blank production did not utilize radial preparation nor, in some cases, produce only a single blank per Levallois surface.

The identification of a Levallois technology in a Middle Paleolithic assemblage has concentrated on the characteristics of the blanks produced. Dibble (1989) has argued that the Levallois technology was a strategy to produce a series of flakes that are consistently the same size and shape. This approach has been criticized on several grounds, specifically that there is rarely a "middle-range" linkage developed between the end products (blanks) and the strategy used to produce them (Van Peer 1992:8). In other words, without refitting the flakes to the cores we cannot be certain whether they were produced by a Levallois technique. Boker Tachtit, in the Negev in Israel, is a case in point, wherein morphologically similar "Levallois points" were produced throughout a stratigraphic sequence by a Levallois technique in older levels and by a non-Levallois technique in the uppermost level (Volkman 1983). The points themselves, the by-products of very different reduction sequences, were morphologically unchanged throughout.

Van Peer (1992) has defined the strategy of Levallois core reduction as one that constantly monitors the Levallois surface or exploitable volume of the core. that produces very few end products from each surface before it has to be renewed or abandoned, and that insures these end products are the largest ones possible given the surface area of the core. Predetermination is still a large part of the Van Peer definition the Levallois. In addition, Van Peer (1992:111) argues that "a Levallois method for blades does not exist." Those blades defined as Levallois (most prevalent in the Levantine Mousterian) are produced with a strategy that "ceases to use the Levallois concept" (see above). Van Peer's conception of Levallois has been influenced to a large degree by Boeda's approach to the subject.

Boeda (1988a, 1995; Boeda et al. 1990) defines Levallois in terms of core preparation and maintenance that sustains the convexity of the flaking surface of the core with the striking platform. This "volumetric" approach consists of a "Linear Method" that produces a single Levallois flake per prepared surface, and a "Recurrent Method" from which a series of Levallois flakes is produced from each surface. Levallois technology is merely a reduction strategy that preserves the symmetry of the core in order to cultivate the production of certain types of flakes. Why such a core reduction technique is utilized or needed rather than some other technique is never addressed. Boeda's (1995) approach identifies and describes his view of Levallois techniques in great detail but assumes from the beginning that these data are due to tradition and ethnicity. He never considers that there may be other explanations for a population utilizing this technology. For example, Fish (1979:130) has argued that Levallois was a response to or a technological choice made as a result of greater raw material availability. However, it is clear at this point in time that researchers are more interested in identifying Levallois technology, rather than explaining it (e.g., Dibble and Bar-Yosef 1995). Unfortunately, identifying Levallois technology is difficult, at best.

The use of the products of a supposed Levallois technology to identify that technology is circular reasoning at best, and inaccurate at worst. Evidence for other methods has been found at Middle Paleolithic sites, such as the discoidal technique, which produces by-products that are very similar to those produced by a Levallois method. Along these lines, many researchers tend to separate "disc" cores from Levallois cores. assuming there are major technological differences between the two (Sato et al. 1995). It should be noted, however, that Bordes (1953, in Ohnuma 1995:258) thought of discoidal and Levallois cores as the same

technologically, with the differences between them being due to raw material and site location. Ohnuma (1995) was able to demonstrate through experimental replication that it can be very difficult to distinguish between what are called discoidal and what are called Levallois cores (see also Baumler 1988). In addition, what could be classified as Levallois debitage was produced by both techniques, although discoidal cores produce pseudo-Levallois points and apparently the Levallois method does not. Given the similarity between these methods, we cannot discount the relationship between them.

The tremendous diversity in the definitions and the criteria used to identify Levallois technology, coupled with the fact that what can be identified as Levallois cores and Levallois flakes could have been produced by non-Levallois methods, precludes the use of this terminology here. The term "centripetal reduction" is used in this analysis to describe any radial flaking of a core or flake that is contrasted with a uni- or bidirectional flaking technique. This approach identifies potentially different reduction strategies, or stages in a single reduction strategy, without dealing with the term Levallois and all the associated confusion attached to it.

Summary

The technological models discussed should be thought of as subsets of the landscape models. Unfortunately, very little "middle-range research" has been done to link the tactics of reduction with the settlement-subsistence models needed to really understand what was happening "on the ground" during the Middle Paleolithic. Conversely, a similar problem of linkage exists when attempting to project human land-use models back on the lithic assemblages themselves.

Land-use models that rely on generalizations such as collectors or foragers or circulating and radiating settlement patterns come at the problem of hunter-gatherer adaptation, and consequently lithic technology, from the perspective of ethnographic analogy and the environmental parameters that make people move over the landscape. Unfortunately, the consequences of these moves for lithic technology are, in many cases, an afterthought. Yet, expectations about assemblage content and variability are usually outlined for each model. However, suggesting that foragers will use primarily expedient technologies whereas collectors will depend on curated technologies masks a great deal of variability in how people make and use stone tools. It is clear that very few hunter-gatherer groups today or in the historically documented past used an expedient technology to solve their day-to-day problems. People carry at least some stone with them because no environment is completely predictable or homogeneous when it comes to raw material. No purely expedient technology probably ever existed among hominids, at least since *Homo erectus*. We are, therefore, left with degrees of curation. This viewpoint dilutes the utility of curation considerably as a heuristic device because multipurpose tools, heavily retouched tools, etc., at a site do not, by themselves, inform us about settlement patterns as much as we thought they did.

Technological models address hunter-gatherer adaptation from the perspective of lithic technology by attempting to replicate the entire process of creating a stone tool assemblage. *Chaîne opératoire* is an attempt by archaeologists to understand this process, albeit from the standpoint of cultural differences and traditional choices. The problem with technological models is in the projection of these stages of reduction, resharpening, use, discard, etc., from an assemblage or site to a region and a land-use model. Most technological approaches can describe in great detail the lithics in question and what "technology" was used at a site but cannot, as of yet, explain why they should be this way and how the reduction process is integrated in a settlement-subsistence system. Changes in technology are studied as ends in themselves rather than the means to the end. Reduction models, such as Dibble's scraper reduction, must be used as one way to understand tool use and maintenance rather than as the only way.

As stated above, technological models should be thought of as a subset of land-use models. The only way we are going to learn anything about the Middle Paleolithic is to work at this problem from both perspectives. By moving back and forth between the lithics themselves and how lithic technology is organized on the prehistoric landscape, we can begin to build more productive models of technological adaptation to the environment.

The initial approach taken in this volume examines the chipped stone assemblages from the seven Zagros sites from a technological perspective. The following chapter outlines the methodology of this approach in more detail. The results of the technological analysis are then examined in terms of how the landscape affected and was used by hominids during the Middle Paleolithic in this mountainous region.

7

Methodology

Paleolithic archaeologists have studied a variety of stone assemblage attributes in an attempt to understand the dynamics of making, using, reusing, and discarding "tools" (Baumler 1988; Bordes 1961a, 1961b, 1972; Dibble 1987a, 1987b, 1995a; Fish 1979, 1981; Holdaway et al. 1996; Kuhn 1990a, 1992a, 1992b, 1994). Since chipped stone remains are frequently the only material recovered from Paleolithic sites, it becomes critical that the attributes selected for analysis be meaningful in terms of the behavioral inferences that we can derive from them. This is rarely the case, however. Most lithic studies describe the variables that were measured or document how the analysis will proceed without explaining why assemblages are being analyzed in this way or what is hoped to be learned from the attributes studied. Groups of attributes from one site or assemblage are compared to groups of attributes from another in the same area from the same time span in a pattern search. Sites or assemblages are then grouped by similarities and post-hoc questions are addressed.

The attributes by themselves do not inform us about how lithic technology was organized, what problems certain techniques solved, how stone tools reflect the settlement-subsistence behavior of the hominids of interest, etc. It is the theory behind these potential analytical units that must address these important questions (see Chapter 6)

There has been some criticism of how lithic analysis has been done in the past. Ahler (1989) has suggested that the traditional individual flake analysis done by most lithic analysts is problematical. He has outlined several problems with this type of study: (1) Only complete flakes can be utilized; (2) Studying individual flakes is time consuming; (3) The studies usually use only larger flakes (usually those greater than 2 cm in maximum diameter) and therefore potentially ignore important technological behaviors; (4) Attributes studied are subjectively chosen and defined, and they vary by individual researcher; and (5) Individual flake types and attributes can be produced by a variety of techniques and do not necessarily correspond to specific human behavior or intent. Ahler's criticisms are well taken though not necessarily entirely satisfied by his alternative "mass analysis" system.

It is true, as Ahler (1989) has suggested, that most lithic studies concentrate on whole flakes because many of the attributes studied cannot be documented on broken pieces. Theoretically, complete flakes provide unambiguous information about their manufacture and reduction. However, as the section on Levallois technology in the previous chapter demonstrated, this is not always the case.

The time involved in studying flakes on an individual basis is staggering, yet the benefits of collecting data not obtainable through other analyses make this type of analysis potentially worthwhile depending on the questions being asked. For example, Kuhn (1990a:206) was able to distinguish flake types and, in turn, different strategies of lithic provisioning at Middle Paleolithic Pontinian assemblages in Italy by using platform treatment, pattern of dorsal scars, and dorsal cortex cover. Only the individual analysis of flake blanks could provide this information.

Most lithic studies do use an arbitrary size cutoff of 2 cm In part, this size is at the limit of what a researcher can accurately see on a flake. It is true that the majority of flakes in a completely collected lithic assemblage are smaller than this and that information about this aspect of technology is "lost." However, it is also important to remember that size had to have been a limiting factor in the manufacture and selection of blanks for utilization as tools in most assemblages. The ability of (and necessity for) most hominids to grasp a 1-cm-wide flake and use it for some task had to have been somewhat limited, not to mention the question of the utility of such a flake to perform a task in the first place. On the other hand, the presence of an inordinately large number of retouch flakes produced from the resharpening of scrapers coupled with a lack of scrapers in an assemblage would provide provocative information regarding the transport of tools around the landscape. In these cases, Ahler's "mass analysis" system would be invaluable in isolating this type of flake.

The most damaging criticism by Ahler is that the attributes used by most lithic studies are subjectively chosen. In many cases this is true, with researchers adopting tool labels by analogy to modern life for similarly shaped pieces and describing in great detail how these attributes were analyzed but not explaining or demonstrating why they should be studied. The following methodology section will describe both how and why the attributes used in this study were selected.

The final criticism by Ahler, that individual flake types and attributes can be produced by a variety of

techniques and do not necessarily correspond to specific human behavior, is only partly true as Kuhn (1990a) has demonstrated for Pontinian assemblages in Italy. Ahler (1989) uses a study of flakes produced experimentally by four different techniques on Knife River Flint to demonstrate that specific flake types, such as bifacial thinning flakes, can be produced by a variety of techniques and therefore are useless in the identification of specific lithic reduction methods. Yet, the overwhelming majority of flakes produced for his study are either "shatter" or "unknown." Obviously, neither type of flake is very useful in identifying technology in any lithic assemblage. Ahler is attempting to derive the most information possible from the simplest variables he can monitor, i.e., flake size grades and weight, cortex frequencies by size, and mean flake weight by size. He argues that these variables "should be highly sensitive to behavioral variation in flintknapping practices" (Ahler 1989:93) because flintknapping is reductive and sequential. In this way, reduction sequences can be easily monitored using this technique. However, reduction sequences can also be studied through the analysis of assemblages by individual whole flakes as well, although perhaps not as quickly.

Research by lithic analysts in the New World has tended to be more explicit in attempts to make behavioral inferences from the study of stone assemblages (Nelson 1991; Odell 1996; Magne 1981; Pokotylo 1978). Most of the linkage between variables studied and behavior have been made with the help of replicative studies (Flenniken 1981) and will be discussed below.

Flake and Tool Attributes Used in This Study

The following is a description of the attributes utilized in this study. Admittedly, the reasoning for the use of some of these observations can be questioned. This is unavoidable in post-typological studies of lithic technology, since we still do not have a specific understanding of what many of these attributes communicate about stone assemblages. However, they can contribute to our knowledge of technological organization during the Zagros Mousterian in a broad sense.

Length, Width, Thickness

Flintknapping is a reductive technology (Collins 1975:16). It has been demonstrated experimentally that by documenting the maximum size of flaking debris, we can indirectly arrive at a measure of the size of the raw material being processed and, therefore, the position in a reduction sequence from which the debris was produced (Newcomer 1971). Of course, this observation would be dependent upon having a large enough sample of debitage. The size of the raw material used affects many aspects of the lithic assemblage. McHugh and Mitchum (1981) suggest that the initial cobble/blank size has an important effect on flake size distribution. Although this may appear obvious, there is quite a bit of variation in flake types and tool forms can be produced from even small raw material (Svoboda 1987). In general, however, initial flake blank size will always be constricted by the size of the raw material available.

Flake size can be monitored in several ways. Some researchers have suggested that the weight of a flake can be used to predict where it came from in a biface reduction sequence in the context of an entire assemblage (Burton 1980; Magne and Pokotylo 1981). In contrast, Magne (1981) found that the weight of individual flakes was not significant in identifying reduction stages. He found biface reduction stages could be predicted with an 80% accuracy rate by studying complete flakes by platform scar count and that dorsal scar complexity could be used to predict these stages for broken flakes. Of course, platform scar count and dorsal complexity will be affected by flake size (Amick et al. 1988). However, there is ample evidence to suggest that size is an adequate coarse-grained predictor of reduction stage (Ahler 1989; Katz 1976; Pokotylo 1978). All things being equal, larger flakes should be from earlier in a reduction sequence than smaller flakes. The problem with this line of reasoning is that, theoretically and in practice, small flakes can be produced during any stage of reduction, although there should be a decreasing variance in flake size through the reduction trajectory (Newcomer 1971). Lithic experiments suggest individual flake size may be a weak predictor of reduction stages but could be helpful in suggesting the mode of flake removal (Mauldin and Amick 1989). A better approach might be to compare the range of flake sizes between assemblages. In addition, Speth (1972, 1974, 1975, 1981) has suggested flake thickness is important in predicting flake sizes (and weights) and, therefore, reduction stages (see also Dibble and Pelcin 1995).

The range of overall sizes in an assemblage provides an analytical baseline from which to compare other assemblages in the same region and roughly the same time period. If raw material size is the same, a variation in size of flake blanks, tools, etc., between sites could suggest distance from raw material sources or different positions that these places had in a reduction/production sequence and therefore differences in site function, lengths of occupation, and activities that occurred. For example, Raab et al. (1979), based on experimental biface manufacture, found that when they plotted debitage size distributions for several sites in Arkansas they could distinguish between those sites with short production trajectories (containing only small flakes) and those with long production trajectories (containing a full size-range of flakes). They interpreted short trajectory assemblages as short-term extraction sites and long trajectory assemblages as maintenance activity sites (see also Johnson 1989).

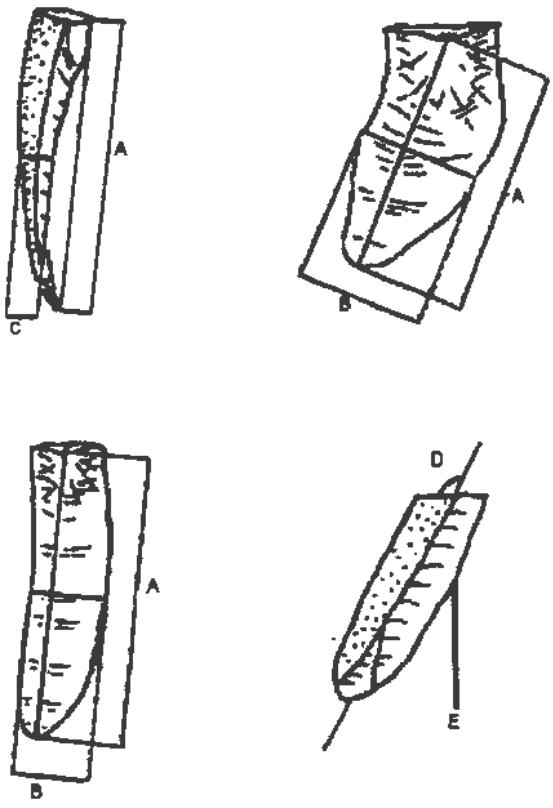
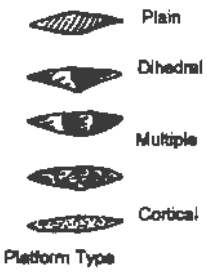


Figure 12. Measurements made on whole flakes: (A) length, (B) width, and (C) thickness. (D) Angle of skew measured from (E) the axis of flaking (from Jelinek 1977:89).



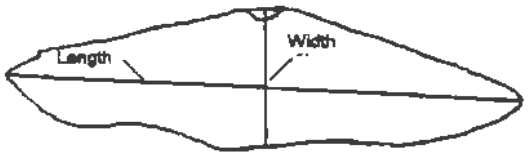


Figure 13. Platform type and measurement.

In the Old World, comparisons of aspects of flake size have produced interesting results. Jelinek (1977, 1981) has argued that the variance in the width/thickness ratio of Levantine Middle Paleolithic flakes becomes smaller through time, possibly indicating greater manual dexterity and control through time. Fish (1979, 1981) utilized metric data to distinguish between the sizes of debitage and sidescrapers from Middle Paleolithic assemblages from Europe and the Levant in Southwest Asia. Henry (1989) has suggested that the measurement of flake size, tool size, and the final flake removal facets left on cores from an assemblage can be used to reconstruct the initial size of raw material, the degree of core exhaustion, the selection of specific blanks/tool sizes, and levels of production efficiency. It is clear that gross size can provide important information on a chipped stone assemblage.

In the present study, length, width, and thickness measurements were taken on all complete flakes greater than 2 cm in maximum dimension. Length was measured from the point of percussion, or apex, to the most distant point on the interior surface. Width was measured at the midpoint, at a right angle to length on the interior surface. Thickness was measured at the midpoint of width (Figure 12).

Platform Width and Thickness

The overall size of the platform as well as its maximum width and thickness are argued to be related to the initial size of the blank (Dibble 1987a, 1995a; Dibble and Pelcin 1995; Dibble and Whitaker 1981; Speth 1972, 1974, 1975, 1981, however, see Mellars 1996:109). Platform width is defined and measured as the maximum distance between left and right extremities of the platform, and platform thickness is measured perpendicular to the midpoint of platform width (Figure 13).

Based on this information, platform size has been used, along with other attributes such as thickness and platform angle, to predict the original size of the blanks from which scrapers were reduced for several Middle Paleolithic sites in Europe and Southwest Asia (Dibble 1987a, 1987b, 1995a). More recently, platform thickness (along with exterior platform angle) has been shown to predict flake size in controlled knapping experiments (Dibble and Pelcin 1995). Platform width was not informative at all regarding flake size in this latter study. In heavily reduced assemblages such as those found in the Zagros Mousterian, the ability to predict original blank size provides invaluable information regarding tool reduction.

Platform Characteristics

Platform scar counts have been used to predict reduction stages in debitage experiments of New World lithic biface assemblages (Magne 1981). In general, as a core or biface is reduced, more flake scars are created, and this will be reflected on the platforms of the blanks produced. How well this attribute will work in the Old World Paleolithic remains to be seen because, as in techniques such as those labeled "Levallois," the

platform is prepared by flaking to accept the blow for the removal. In such cases the number of platform scars would be irrelevant for predicting stage of reduction but might help identify different flake products produced by different manufacturing trajectories. For example, Kuhn (1990a) used platform characteristics as one of the three variables to identify flake types in the Pontinian of eastern Italy.

In this study platform reduction is noted in six stages from missing to heavily faceted. A missing platform means no measurable platform, whereas a heavily faceted platform has at least ten scars.

In addition, platform shape can give an indication of the morphology and preparation of the core. The shapes noted in this study are flat, irregular, concave, peaked, rounded, chapeau du gendarme, indeterminate, and missing (Figure 14).

Technique of Core Reduction and Blank Morphology

"Raw material may affect sizes of flake blanks, but the shapes of flakes are probably most directly determined by techniques of core reduction" (Kuhn 1992b:125). Tactics of core reduction have been linked to patterns of mobility, the economy of raw material use, and functional advantages of different blank forms. Blank form or shape has also been argued to affect the scraper types produced (Kuhn 1992b).

Flake blank and tool forms are noted from nine different shapes based on ideal parallel, divergent, convergent, hourglass, and expanded forms (Figure 15). In some cases, retouch obscures the original blank shape of some tools. This will be noted in the analysis.

Typology

The importance of the development of a typology for organizing Lower and Middle Paleolithic assemblages in France by Francois Bordes (1961a, 1961b) cannot be underestimated. Bordes defined 63 different types of flake implements based on different types of retouch, the location of retouch on a blank, and technological differences between the blanks. Mousterian industries in France were defined on the basis of variation in the frequency of these 63 types. Bordes describes four industrial facies for southwestern Europe: (1) the Charentian Mousterian, which has an abundance of scrapers and is divided into Ferrassie and Quina sub-facies based on the frequency of Levallois technique; (2) the Denticulate Mousterian, dominated by pieces with notches and denticulates; (3) the Mousterian of Acheulean Tradition, containing more handaxes; and (4) the Typical Mousterian, characterized by all the major typological classes except handaxes. While these industrial facies do not exist in the Zagros region per se, they provide the basis for every subsequent typology used in the Old World today.

Differences over the interpretation of the Bordian typology and the subsequent patterning he discovered at

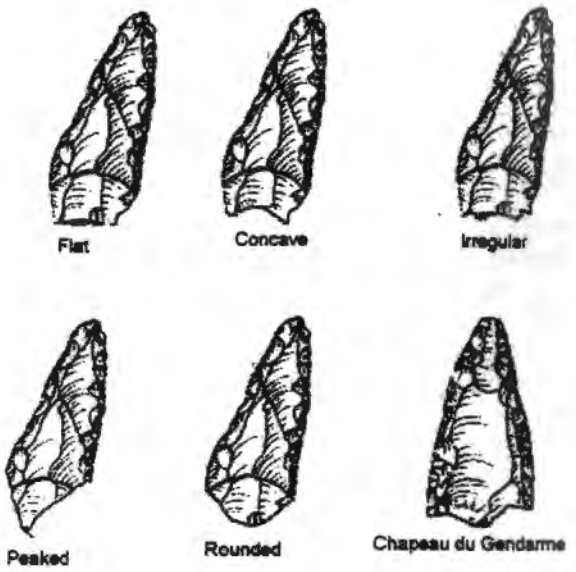


Figure 14. Platform shapes.

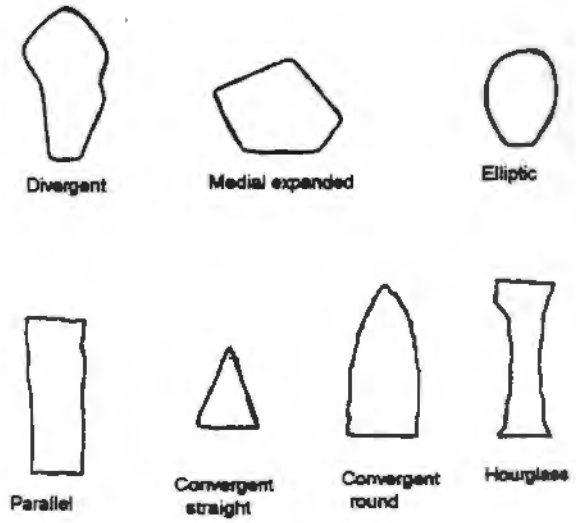


Figure 15. Flake and tool shapes.

Middle Paleolithic sites in France have occurred almost from the beginning of its use (Bordes 1961b, 1977; Bordes and de Sonneville-Bordes 1970; also see Barton 1988, 1990, 1991; Binford 1972, 1973; Binford and Binford 1966; Dibble 1987a, 1987b, 1995a; Dibble and Rolland 1992; Mellars 1965, 1969; Rolland 1977, 1981; Rolland and Dibble 1990). In this study, the Bordian typology and tool types are used as a form of lingua franca for comparing and discussing tool assemblages from Zagros Middle Paleolithic sites.

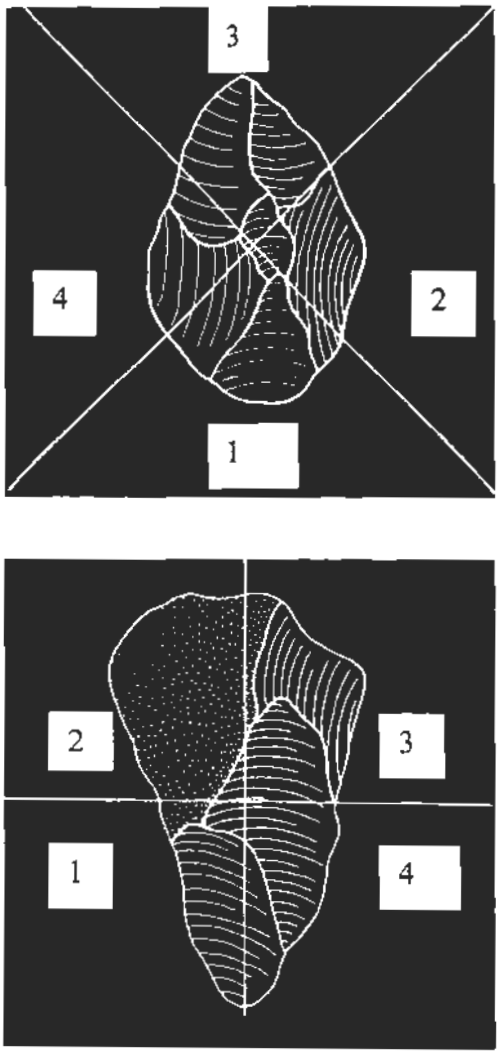


Figure 16. Dorsal scar pattern (*top*) and cortex placement (*bottom*) on whole flakes (Baumler 1988:263).

Dorsal Scar Count and Complexity

In the New World, Amick et al. (1988) have demonstrated that dorsal scar counts on flake removals are helpful for identifying the earlier stages of biface production. However, Mauldin and Amick (1989) suggest dorsal scar patterning alone cannot be used to distinguish reduction stages in bifacial and block cores. In the Old World, Kuhn (1990a) chose dorsal scar patterning as one of the attributes he used to distinguish flake types and hence technologies in Pontinian assemblages of west-central Italy. Baumler (1988) demonstrated that dorsal scar morphology can be used to document changes in reduction strategies in an individual reduction sequence not identifiable through the study of final core morphology. Although the results of these studies are not conclusive, it appears that studying dorsal scar patterning might provide information regarding stages of reduction in most assemblages where core (as opposed to biface) reduction occurred. Therefore, I document dorsal scar pattern for all whole flakes to investigate the possible technological relationships between different scar patterns.

In addition, following Baumler (1988) and Crew (1975), a four directional grid is used to count the number and the direction of exterior flake scars on each flake and retouched piece (Figure 16).

Cortex Amount and Location

Amick et al. (1988) have suggested that cortex percentages can be used to identify the early stages of biface reduction. However, Mauldin and Amick (1989) argue that the percentage of cortex cover on flake blanks can only be used to distinguish the earliest reduction debitage. Tomka (1989) found that a core reduction strategy produced primarily margin and distal end cortex locations but very few 100% cortical flakes. Kuhn (1990a) used cortex as one of the characteristics of distinguishing flake types recovered from the Italian Pontinian. Consequently, there is some evidence to suggest that cortex as related to flake size will vary with technology, stage of manufacture, and size, shape, and type of raw material.

A four directional grid is used to measure the amount and location of cortex for each flake and retouched piece (Figure 16).

Reduction

As described in Chapter 6, Dibble (1984a, 1987a, 1987b, 1995a) has recently argued that many of the formal scraper types identified by Bordes are actually stages in a reduction/resharpening sequence. In order to assess the amount of material removed through resharpening, the original size of the blank must be predicted. The flake thickness, platform thickness, and exterior platform angle of a flake have been argued to be accurate predictors of the flake area (Dibble and Pelcin 1995). *The entire basis for his model depends on the accuracy of this assumption.* As noted above, there is some empirical evidence to support this argument (Dibble 1995a; Dibble and Whittaker 1981; Dibble and Pelcin 1995).

Through experimental evidence Dibble has documented the relationship between the original size of a flake and the platform area, more specifically platform thickness, and exterior platform angle (Dibble and Whittaker 1981; Dibble and Pelcin 1995). The value of obtaining an accurate measurement of these data is that it allows the prediction of original flake size and consequently the degree of reduction through resharpening that has occurred. For example, heavily reduced flakes will have a ratio of surface area to platform area that is lower than expected. As Dibble is quick to point out, this is an assemblage-specific measurement and should not be applied across assemblages.

The reduction model has been tested and criticized (Barton 1988; Baumler and Speth 1993; Close 1991; Kuhn 1992b, 1994; Mellars 1996:108–109). Dibble (1995a:340) has responded to most of these studies by pointing out that, in most cases, the method of measurement was different for both size characteristics such as length and width and also for calculating retouch intensity values. Length, in these other tests of the model, was measured from the point of percussion, or apex, to the most distant point on the interior surface, and width was not measured at the midpoint of length. In addition, retouch intensity was calculated differently for tools used in the other studies. Platform area (platform width multiplied by platform thickness) is another difficult measurement owing to irregularities inherent in this part of any flake. These differences could have caused the discrepancies seen in the other studies.

The artifacts studied for this project were measured in the same manner as that used by Dibble (Jelinek 1977; see above). Consequently, the primary problem with assessing and using the reduction model is in calculating or determining the degree of reduction objectively. Dibble has utilized a subjective categorization of retouch intensity that can be affected by inter-researcher error and interpretation. There are better ways to document retouch intensity, as even Dibble (1995:330) has suggested.

Kuhn (1990b) has developed an index of reduction for unifacially retouched tools based on a formula utilizing depth of retouch, angle of retouched edge, and maximum thickness of the retouched piece. The values range from 0 to 1.0 as retouch intensity or resharpening increases.

Retouch intensity for all retouched tools from the Zagros assemblages was measured and calculated using Kuhn's technique. This kind of direct measurement, rather than a subjective selection of the most appropriate retouch category, should provide fairly unambiguous information on resharpening from these sites.

Flake Termination and Orientation

The orientation of the axis of flaking for a blank or the angle of divergence might provide insights into flake selection since assemblages may contain only those blanks that are skewed because straighter flakes were removed from the population for use as tools. Each complete flake is placed on a grid and an angle of divergence determined. It is assumed that the object of a reduction strategy is to produce usable, reasonably symmetrical blanks.

Core Attributes Used in This Study

Raw material can, in many ways, affect the techniques used in the production of flake blanks in a lithic assemblage. Kuhn (1990a) argues that core form should reflect the overall technological decisions by tool makers in coastal Middle Paleolithic Pontinian assemblages. The Pontinian is a special case, however, as the raw material utilized is quite small and therefore the reduction sequences that occurred were so short that the cores recovered from these sites probably *do* reflect the majority of technological decisions. In other cases, where the raw material is larger, the morphology of cores would reflect only the final stages of blank production. Evidence of earlier strategies would have been effectively erased on cores that were reduced to "exhaustion." However, the evidence of early strategies during core reduction might still be present on the debitage component (see Baumler 1988 and discussion above). Therefore, the final size and shape of cores more than likely reflects only the last stages of a reduction sequence. Be that as it may, the study of cores from an assemblage can be quite informative about these final stages and the amount of raw material stress that existed, how the technology changed (or did not), etc., when compared to flake removals that occurred earlier in the sequence.

The question of Nahr Ibrahm cores or truncated/faceted pieces should be addressed here because *in this study these objects are treated as cores rather than tools*. First noted in the Levant (Schroeder 1969; Solecki and Solecki 1970), these artifacts are normally made on a flake and can have flakes removed from both the interior (ventral) and exterior (dorsal) surfaces along, most commonly, one or two edges. The truncations are usually seen on the interior face with the faceting being located on the exterior face. The types of flakes showing this modification can be on any type of tool or unretouched blank. Goren-Inbar (1988:40) points out that the removals from these objects are similar in size to flakes removed from so-called exhausted cores at the Mousterian site of Quneitra, in the Levant. The viewpoint taken here is that these are flakes expediently used as cores when raw material was not near at hand or was scarce. The following attributes were recorded for cores.

Core Size

Final core size should define how raw material was economized in an assemblage. However, without knowing the original size of the raw material it can be difficult to determine how much reduction took place. The Zagros assemblages studied here were primarily made on pebble raw material that was relatively small to begin with.

When possible, the final axis of flaking is determined on all complete cores and then the length, width, and thickness is measured (Figure 17). Centripetally flaked cores will not normally have a main axis of flaking, so one will be chosen at random on the "best" flaking surface and measurements will be made for the three variables.

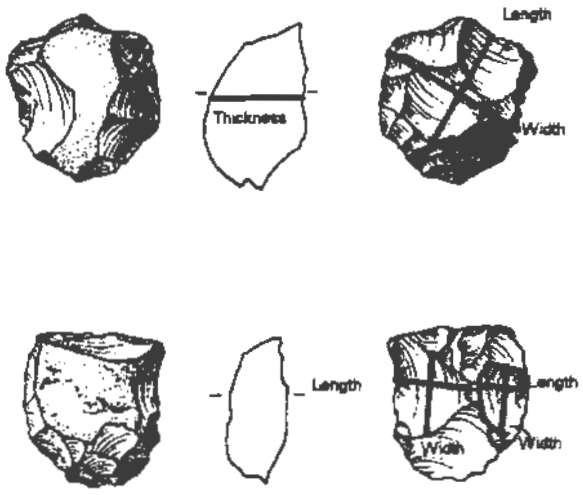


Figure 17. Measurements made on cores: (*top*) length, width, and thickness for whole cores; (*bottom*) length and width for last complete flake scar(s) on a whole core.

Last Scar Size

Henry (1989) has argued that the size of the final core facets can be compared with the primary elements and flakes from an assemblage to determine the degree of exhaustion in an assemblage (see also Barton 1988). To this end, the length and width of the final removals on each core are measured (Figure 17).

Scar Number

The number of scars on a core can also reflect the degree of exhaustion, with more facets indicating a more exhausted core. All complete facets were counted for each whole core.

Cortex Percentage

The amount of cortex remaining on a core can suggest the degree to which the core was reduced and the original size and shape of raw material selected. The amount of cortex was estimated for each complete core as a percentage of the total surface area.

Core Type/Technique

Cores are classified based on the type of blanks removed—i.e., flake versus blade; the number of platforms and the direction of removal—e.g., bidirectional, double platform; and the morphological characteristics of the core—e.g., truncated/faceted. This process, again, can only identify the final result of the reduction strategy used on each core.

Statistics

In this study primarily non-parametric tests will be used. The Mann-Whitney U test will be used to compare data within each site. Spearman Rank Order (Rho) will be used to compare sites with one another in the region.

The Mann-Whitney U test analyzes the separation between two sets of sample scores and allows a determination of probability of getting the obtained separation if both sets of sample scores are random samples from identical populations (Pagano 1994:261). The Mann-Whitney U test is used with an independent group design and does not depend on the shape of the population of scores. In other words, populations do not have to be normally distributed.

A Spearman rank order correlation coefficient is calculated from the ranks of the observations, rather than the observations themselves. Correlation measures the tendency of two variables to "move together," or the degree to which they increase or decrease similarly or in opposition.

Regression analysis is also used in some cases to assess the relationship between variables even though it is not always possible to meet all the requirements for these analyses with the data collected from the Zagros.

Summary

The preceding attributes were selected to provide the most informative analysis of the Zagros Mousterian lithic assemblages possible. The resulting insights into technological organization, reduction strategies, tool manufacture, and tool reduction will allow comparison with other Zagros Mousterian sites and other regions in Southwest Asia where similar analyses have been completed.

8

Zagros Mousterian Site Sample

Seven sites were chosen for study because of their prominence in the characterization of the Zagros Mousterian and because of the accessibility of the collections. These sites are Barda Balka and Shanidar in Iraq and Bisitun, Warwasi, Kobeh, Kunji, and Gar Arjeneh in Iran (Figure 1).

Barda Balka

This site was discovered by Dr. Naji al-Asil, then Director General of Antiquities of Iraq. It was subsequently excavated by H. E. Wright, Jr. and Bruce Howe as part of the Oriental Institute of the University of Chicago and American Schools of Oriental Research project under the direction of Robert J. Braidwood. A four-day sounding of geological and archaeological materials was carried out. The material collected from the surface and from excavation is housed at the Oriental Institute at the University of Chicago.

Barda Balka is an open-air site located at an elevation of approximately 740 m above sea level, three km northeast of Chemchemal in Kirkuk Province, Iraq. The site is located on a hillside containing a now-fossil spring in the Chemchemal Valley near a small tributary of the Cham Shirwa Su, which flows southeast to join the Basira Su and eventually the Tauq River. Barda Balka has a natural limestone monolith rising from the surrounding sediment and was recognized as a Paleolithic site from the numerous artifacts on the surface that appeared to be eroding out of stream gravels. These gravels are overlaid by a thick silt deposit known as the Jarmo Surface (Wright and Howe 1951: Figure 1). This silt layer averages 10 to 25 m in thickness although it can be as much as 65 m deep in some areas (Wright 1952:15). This sequence of gravels and silts is placed roughly in the Pleistocene with the gravels assigned to the junction of the last interglacial and early last glacial periods (ibid.). This would suggest that the deposition of the gravels correlates roughly with isotope stage 5/6 at approximately 130,000 years ago.

Nine test trenches and pits were excavated at the site, and a discontinuous 50-m-long by 1-m-wide trench excavated to a depth of between 1 and 2 m through the site identified six stratigraphic layers as follows:

1. Underlying tilted shale bedrock of Miocene time;
2. approximately 5 m of horizontally bedded stiff, sterile, green clay lying unconformably upon the tilted bedrock;
3. a conformable bed, 25–30 cm thick, of medium-sized stream pebbles containing artifacts of the occupation layer in situ;
4. a conformable layer about 25 cm thick of sterile, reddish buff calcareous silt;
5. a conformable layer about 30 cm thick of sterile, green calcareous silt;
6. a conformable uppermost layer of sterile, reddish buff calcareous silts approximately 3 m thick.

Several other tests were extended from this initial trench to the east and west in order to expose the artifact-rich stream pebble bed (Figure 18).

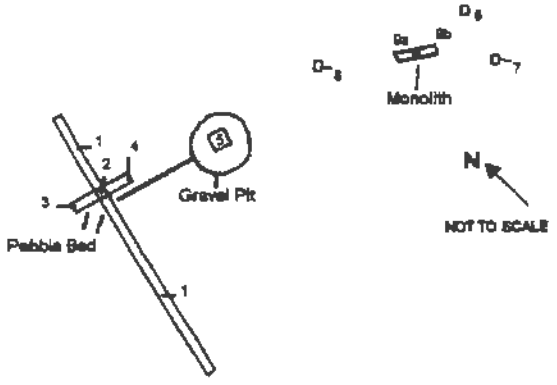


Figure 18. Plan of soundings at Barka Balka (Bruce Howe, pers. comm. 1994).

A 2 m^2 test pit was also located several meters east of the long trench at a depression created by the local population while removing gravel at the site. This test pit was dug to approximately one meter in depth, exposing the stream pebbles and sands intermixed with numerous artifacts. The recovered artifacts consisted of mainly flake debris and tools along with the majority of the faunal remains found at the site.

An additional meter-wide trench was excavated on an east-west axis near the base of the nearby monolith approximately 3.5 m long in order to investigate this structure. The monolith proved to be a remnant limestone conglomerate fossil spring core of sand, gravel, pebbles,

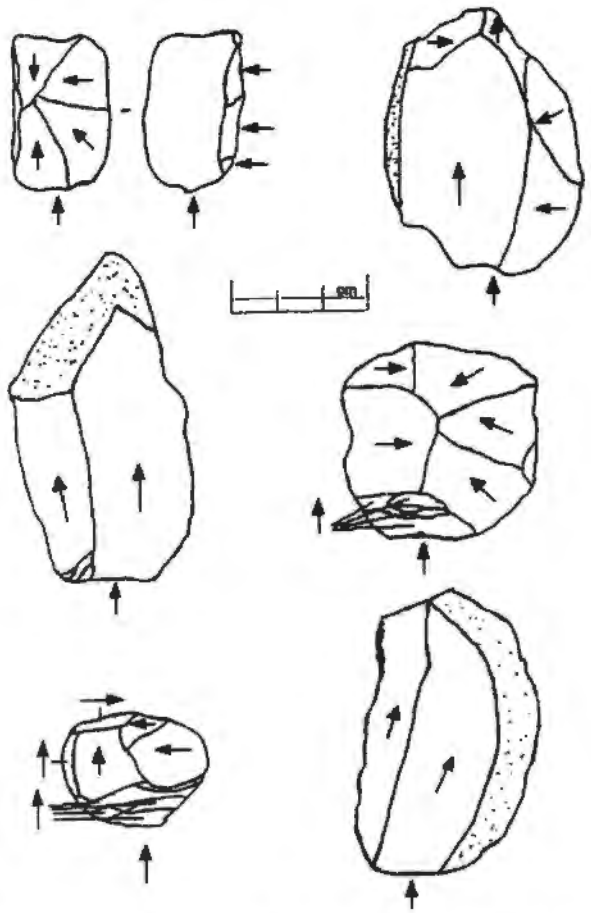


Figure 19. Flakes from Barda Balka, fine-grained component.

artifacts, and animal bone and teeth. Interestingly, its composition was likened to the sand bed found in the 2 m^2 test pit in the old gravel pit depression discussed previously (Wright and Howe 1951).

Three other 1 by 1 m test pits randomly placed and excavated in other areas of the site were sterile (Figure 18).

The artifact assemblage is composed of a flint and limestone flake and flake tool component (Figures 19–22) with associated knapping debris and also contained large pebble tools and choppers of limestone and handaxes of flint. All were recovered from the same gravel lenses and are viewed as contemporaneous by the excavators. Detailed analysis has been made and awaits publication following the preliminary, very brief description in 1951 (Bruce Howe, personal communication 1991). No other features such as hearths or ash layers were found, suggesting the possibility that these artifacts might be redeposited by fluvial activity. Only the flake assemblage has been used for this study.

There is some question as to the chronological position of Barda Balka and whether it is actually a Middle Paleolithic site or a Lower Paleolithic site. To some, the presence of chopping tools and handaxes at the site places it securely within the Lower Paleolithic (Smith 1986). However, there are Middle Paleolithic sites in other parts of the Old World with handaxe and pebble tool components. The presence of these artifacts could be related more to what was occurring at the site than when the site was deposited. The excavators insist the flake tools and chopper/handaxe component were coming out of the same gravel lenses (Bruce Howe, personal communication 1991).

The age of the site has been estimated by the geological position of the gravel bed that contains the artifacts. Stream-deposited gravels and silts such as these cover the Chemchemal Plain with an average thickness of 10–15 m. An erosional sequence has exposed the underlying bedrock at a depth of 20–50 m. Wright and Howe (1951:168) argue that the Barda Balka material must be relatively old based on its low position in the geological sequence. Indeed, Wright has linked the gravels geologically to near or at the start of the last local glacial interval and to the last glaciation (Wright 1952). With the time frame of the Middle Paleolithic extending back to 300,000 BP in other areas of Southwest Asia, it seems appropriate to compare this site with other Zagros sites that do not contain choppers or handaxes.

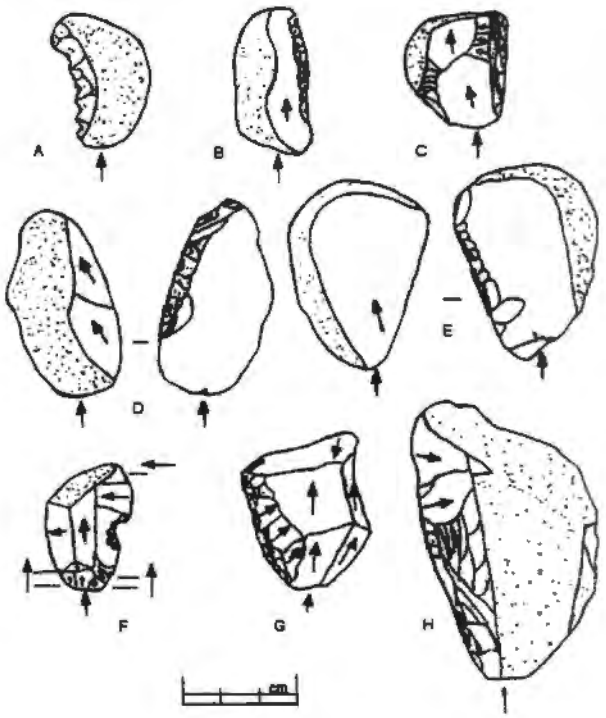


Figure 20. Tools from Barda Balka: denticulate (a), sidescrapers (b, c, g, h), ventral scrapers (d, e), and notch (f).

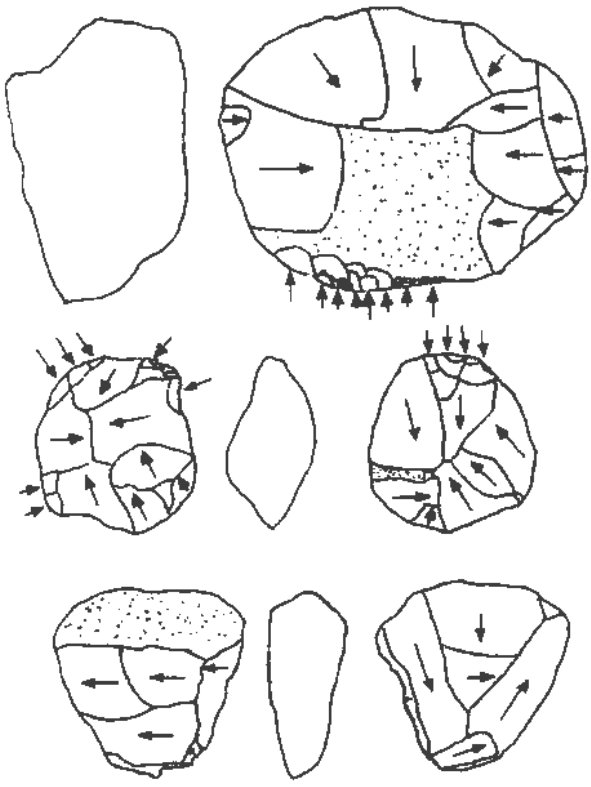


Figure 21. Cores from Barda Balka, fine-grained component.

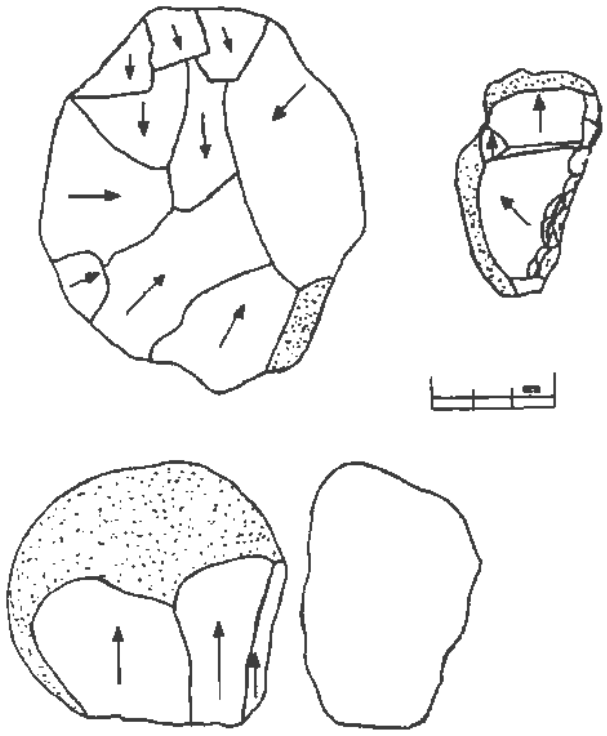


Figure 22. Cores and flake from Barda Balka, coarse-grained component.

Shanidar

Possibly the best known of the Zagros cave sites, Shanidar cave is located in the Ruwanduz district of northern Iraq in a valley formed by the Greater Zab and the Ruwanduz rivers at an elevation of 765 m asl. Discovered by Ralph Solecki in 1951, it has an opening 25 m wide and nearly 8 m high, and is 40 m deep with a maximum width of 53 m. The cave was excavated in four seasons between 1951 and 1960 to a depth of 13.41 m. The test excavations had to be placed around a series of corrals used by modern herders during the winter months. Four cultural layers were identified (A–D from top to bottom). Layer A was considered Neolithic; layer B was assigned to the Epipaleolithic-Zarzian; layer C to the Upper Paleolithic, Aurignacian (see Olszewski 1993); and layer D to the Mousterian, noted as typologically similar to the industry at Hazar Merd (e.g., Garrod 1930). Lithic artifacts recovered from all levels totaled approximately 2,800 pieces (Solecki 1955:408).

Layer D, comprising the Mousterian deposits, begins at 4.88–5.18 m below datum and extends 8.53 m to a depth of over 13 m in the deepest sounding. The sediment consisted of a light brown to yellowish brown sandy loam with limestone boulders scattered throughout. The densest occupation occurred roughly in the middle of layer D from approximately D4a to D4c, but artifact density was never really very high. The deposit was characterized by a large number of hearths and ash lenses: 129 hearths were reported (Solecki and Solecki 1993). Layer D artifacts numbered >1,000 pieces and are characterized by large numbers of points and scrapers along with debitage and cores with an average density of more than over two artifacts/m (Solecki 1955; Solecki and Solecki 1993).

Layer D has since been subdivided into seven major stratigraphic horizons (D1–D7) comprising a total of 31 arbitrary one-foot (30.5 cm) levels. Layer D4 is further divided into three sub-horizons (Solecki and Solecki 1993). Nine distinct episodes of rockfall were documented throughout the Mousterian levels. It has been suggested that these rockfalls occurred during wet, cool periods and were hastened by extensive seismic activity in the Zagros Mountains. The following is a description of the sub-layers of Mousterian layer D (Solecki and Solecki 1993).

Layer D1 (ca. 4.8 – 5.15/5.50 m in depth) consisted of a sticky, dark brown, sandy loam with limestone fragments and charcoal flecks. It contained evidence of rockfall, lithic artifacts, and a number of hearths. The pollen sample suggests a relatively wet environment.

Layer D2 consisted of levels 17–18 and was 5.18 to 5.49 m in depth. The sediment was a light brown sandy loam with few limestone fragments or boulders but some charcoal and artifacts.

Layer D3 (mid-level 18–23) was 5.49–5.79 m to approximately 7 m in depth. This layer is characterized

by a light brown, sandy loam with limestone rockfall, charcoal, artifacts, and hearths.

Layer D4 (levels 23–32) extends from 7.01 m to 10.06 m in depth. The excavators felt initially that they could subdivide this layer into three horizons and that an even finer division might be possible (Solecki and Solecki 1993:121). Layer 4a comprises levels 23 – 25/26 and extends from 7 to 8.1 m in depth. The sediment consists of a dark mixed loam with artifacts, ash, and charcoal lenses. Layer 4b comprises levels 25–26 to levels 28–29, extending from 8.1 to 8.7 m in depth. It is also a dark loam with limestone fragments, a number of hearths, and charcoal truncated at the bottom by rockfall and also by a lime-hardened horizon or crust between levels 28 and 29. Layer 4c (levels 28/29 – 33) ranges from 8.7 to 10 m in depth. It is a layer consisting of dark grayish brown loam with heavy organic content, artifacts, charcoal, and hearths. Another lime-hardened zone with a crustlike texture is present at the base of this layer (levels 32–33).

Layer 5 (levels 33–35) extends between 10 and 10.6 m in depth. The sediment consists of a grayish brown sandy loam with a claylike hardness and few artifacts.

Layer D6 (ca. 10.6–11.3 m in depth) comprises levels 35–37. The sediment is composed of grayish brown sandy loam and contains rockfall, few artifacts, and an 8-cm-thick lime-hardened layer at the base.

Layer D7 begins at the base of layer D6 and extends to bedrock. The sediment was composed of grayish brown sandy loam with limestone fragments, few artifacts, and few hearths.

Skinner (1965) studied 571 tools from both the Iraq and American collections. The assemblage was dominated by Mousterian points and convergent scrapers. He used Shanidar as one of the sites that typified his Group A Mousterian separated from sites in the Levant by a lack of Levallois technique, a high percentage of points and scrapers, moderate occurrence of Quina retouch, etc. This marked the first time anyone had identified the Zagros Mousterian as a separate entity.

Akazawa (1975) studied the Shanidar layer D artifacts housed in the Iraqi National Museum in Baghdad in 1973 and 1974. He examined more than 1,000 lithic artifacts, including 714 tools, 63 tool fragments, 130 cores and core fragments, and 146 "waste pieces." The tool sample was dominated by 90 Mousterian points, 167 sidescrapers, 42 "rods," 88 notched pieces and denticulates, and 147 miscellaneous retouched pieces (Bordes' types 45 to 48). Akazawa emphasized the nearly complete absence of Levallois technique that differentiates Shanidar from Mousterian sites in the Levant.

The Soleckis recently examined 798 retouched tools from layer D in an attempt to determine whether or not convergent-edged pieces were projectile points (Solecki and Solecki 1993). They concluded there is evidence to suggest that at least some of these artifacts were made into points intentionally and were modified for hafting (Figure 23). They also suggest that the abundance of pointed pieces found in layer D were due to the use of a discoidal technique that would produce thick, pointed blanks which could then be made into convergent-edged tools when retouched. They propose that these retouched points were then used in the hunting and the butchering of prey species around the base camp cave.

Bisitun

Bisitun cave is located in Iran approximately 30 km east of the town of Kermanshah near a perennial spring at an elevation of 1,400 m.

Carleton Coon was told of this site in 1948 while in Iraq to study the skeletal material from the Nippur excavations. George Cameron had seen the cave while copying the trilingual cuneiform inscription of Behistun.

Coon began excavating at the site on July 1, 1949, and worked for two weeks. The 2 by 8 m trench extended down approximately 6.5 m below the surface and recovered over 25,000 individual objects (Coon 1951:33) of which 6,349 were "blanks," 5,349 were "scrap," 1,151 were tools, 151 were cores, and 12,542 were animal bones. The Mousterian levels produced the majority of these artifacts, but only 1,571 pieces are stored at the University of Pennsylvania (Dibble 1984b:25), giving some idea of how selective this collection is.

Coon used a terminology to classify the artifacts that was unstandardized at the time. He described an assemblage dominated by retouched points and single- and double-edged scrapers, along with a significant amount of the Levallois technique (Figure 7). Movius' comments regarding the collection (Coon 1951: Appendix II) also emphasize the large number of points in this assemblage but describes a non-Levallois core technology that produced pointed blanks that were then retouched. In his analysis of the collection Coon measured the "butts" of the spear points and noted they were all of similar thickness. In addition, he saw a constant ratio between the number of single-edged and double-edged "knives" (scrapers). No hearths or evidence for fire was found in the excavation, but Coon noted that the mouth or front part of the cave was left unexcavated (Coon 1957:124). The stratigraphy of the cave was as follows: 0–50 cm consisted of a black layer filled with modern and historic debris; below this was a layer of hard, red, "gritty" sediment containing Mousterian tools and debitage. A gradual change occurred to a "smooth," soft, brown sediment to a depth of 6.5 m, and Coon (1957:108) reports a higher density of lithic artifacts in this layer along with "thousands of splinters of (animal) bone." There were very few skulls, teeth, or long bone epiphyses, and most of the bones

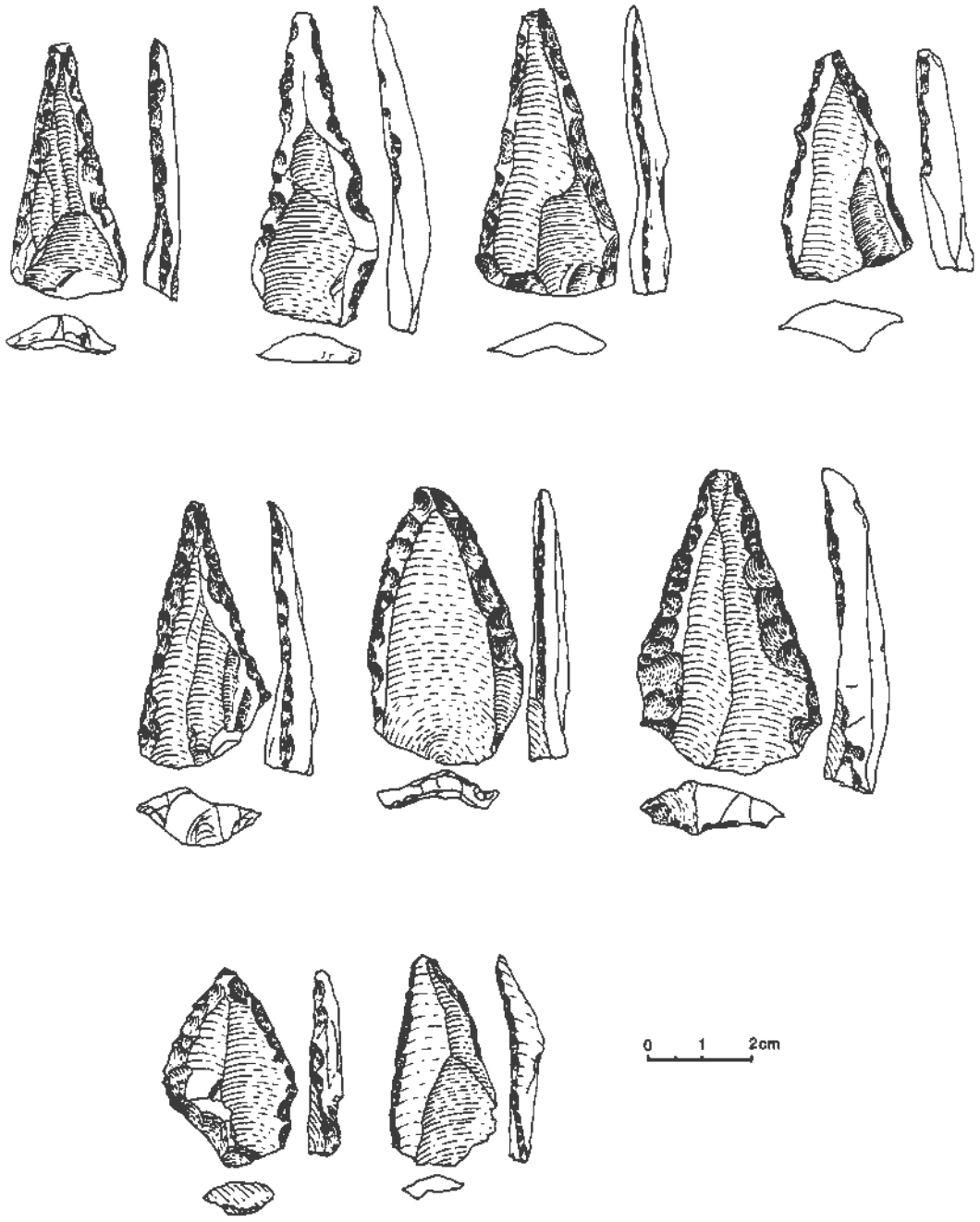


Figure 23. Artifacts from Shanidar Cave (Solecki and Solecki 1993:141).

were long bone fragments. "Articulating pieces" constituted only 1.0% to 11.0% and teeth/jaws only 0.2% to 3.4% of the recovered bones found in each of the Middle Paleolithic levels (Coon 1951:34). The species were identified as red deer and horse.

The lithic collection was analyzed again in the early 1960s by James Skinner, then a graduate student at Columbia University. Skinner analyzed 724 "implements" and lumped Bisitun with Shanidar D, Hazar Merd C, and Kunji into his Group A or Zagros Group (Skinner 1965). Group A is characterized by a low frequency of Levallois technique, high frequency of sidescrapers and Mousterian points, no bifaces, and very few denticulates. Skinner (1965:139) emphatically disagrees with Coon's contention that the Levallois technique was used throughout the Middle Paleolithic levels. It has been suggested that Skinner's study was hampered by the incomplete or "biased" excavation

material selected by Coon and by his only being able to examine approximately 60% of the excavated material housed at the University Museum at the University of Pennsylvania (Dibble 1984b:24). The suggested lack of Levallois technique by Skinner in this (and other) collections has been suggested to be a result of the incomplete sample (ibid.; see below).

The lithic collection was analyzed a third time by Harold Dibble of the University of Pennsylvania (Dibble 1984b). Dibble was able to study all of the excavated material that Coon had brought back to the University Museum and, although this was still only a small percentage of the material excavated, he arrived at a different view of the lithic technology from Skinner. In contrast to the view that the Zagros Mousterian was non-Levallois (i.e., Skinner 1965), Dibble agrees with Coon (1951) that the Bisitun industry actually has a significant frequency of the Levallois technique. In addition, Dibble (1984b) documented a notable presence of the "truncated/ faceted" or "Nahr Ibrahim" technique as well (cf. Solecki 1975). The sampling problem aside, it is possible Skinner (and Movius before him) did not recognize either of these techniques simply because of a more circumscribed view of the defining characteristics of Levallois technology and of what truncated/faceted pieces actually were (see Chapter 9). At any rate, Dibble's study suggested greater variability among the Zagros industries than had previously been suspected.

In addition, Dibble (1984b) was able to document that the tool component remained the same throughout the stratigraphic sequence suggesting remarkable stability for a long period of time. This stability in assemblage composition is also seen at Warwasi.

Warwasi

This rockshelter is located in the Tang-i-Knesht Valley, Kermanshah, Iran, at 1,300–1,400 m asl. It was also excavated by Bruce Howe over a 22-day period as part of Robert Braidwood's Iraqi-Jarmo Project (Braidwood 1960).

A 2 by 8 m trench was excavated to a depth of 5.6 m on the northern edge of the rockshelter, and no natural levels could be discerned. Consequently, 55 arbitrary levels were excavated, each approximately 10 cm thick, labeled A to CCC from top to bottom. Undisturbed Mousterian levels extended from GG to CCC and were overlaid by nearly 3 m of deposits with both Zarzian and Baradostian material (Olszewski 1993a, 1993b). Zarzian artifacts were found from levels A to O and the Baradostian levels were from P to Z. The excavators suspect some mixture occurred between the overlying Baradostian and the Mousterian in levels Z to CC. However, a major rockfall in level BB to levels EE–FF appears to have effectively sealed off the Mousterian in levels GG and below. The size of the test trench gradually diminished with depth as the shelter walls closed in. Not all lithic material was collected from the excavations, as 12,620 unworked flakes, fragments, chunks, and chips were counted and disposed of (Bruce Howe, personal communication).

Mousterian levels JJ to CCC were recently analyzed by Dibble and Holdaway (1993), and they conclude the assemblage is similar to other Zagros assemblages although, as seen at Bisitun, it reflects a greater Levallois component than previously believed. In addition, and as at Bisitun, significant numbers of truncated/faceted pieces are present at Warwasi (Figure 9). Dibble and Holdaway (1993:80) suggest that most of the interassemblage variability seen at Warwasi and other Zagros Mousterian sites is due to scraper reduction and that this ultimately must be related to raw material stress, mobility, and site function.

Kobeh

This cave is located in Iran north of Kermanshah close to the site of Warwasi at an altitude of 1,300–1,400 m asl. Kobeh was excavated by Bruce Howe in 1959 as part of the Iranian Prehistoric Project (Braidwood 1960). The cave site measured approximately 6 to 7 m wide and 20 to 25 m deep (Figure 24). A 2 by 2.5 m sounding was excavated to a depth of 3.40–3.60 m below the surface where excavators encountered a large layer of rockfall resting on a sterile clay layer. The excavation was by arbitrary levels of 10 cm each except for level B (20 cm) and level R (15 cm).

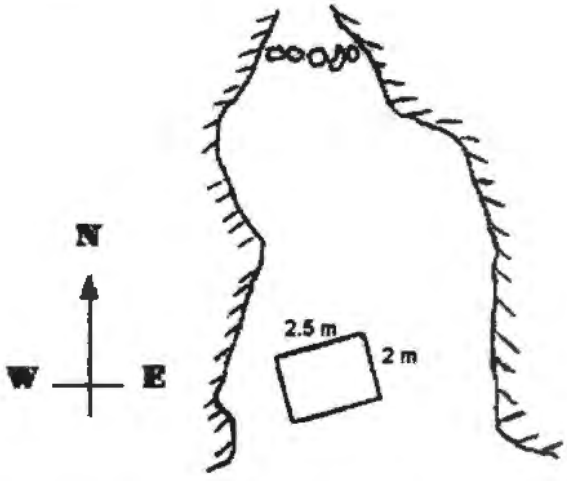


Figure 24. Plan view of Kobeh Cave with location of test unit (Bruce Howe, personal communication).

Unlike many Mousterian sites in the area, only Mousterian levels were found at the site with no Baradostian or Zarzian deposits present. While some levels (A–O) have Uruk to modern period pottery and some have pottery and Mousterian artifacts mixed

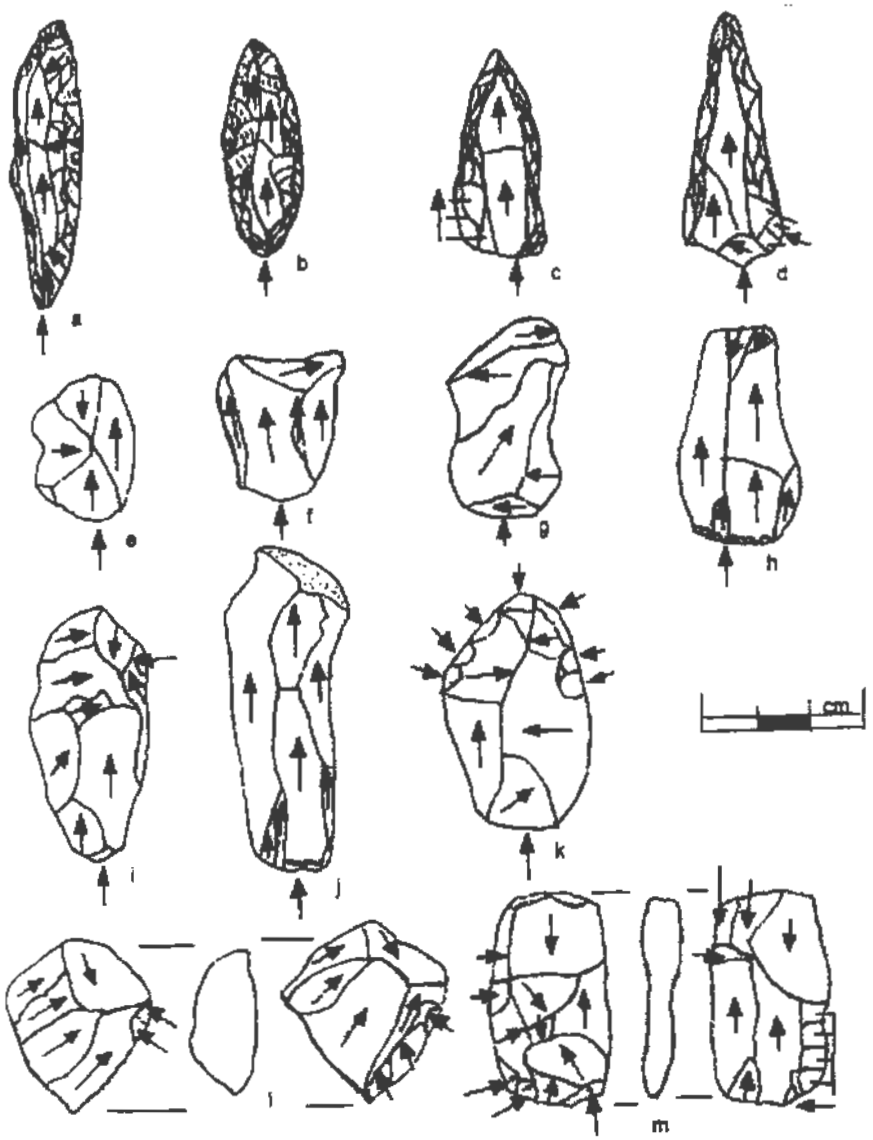


Figure 25. Artifacts from Kobeh: tools (a–d), flakes (e–k), and cores (l, m).

together (M and N), these levels directly overlie the discrete Mousterian levels (P–EE). Levels A–O are characterized by a loose, rust-colored, ashy sediment down to approximately 1.50 m in depth. There is a definite physical change in the sediment at level M/N, with Mousterian levels P–EE being characterized by a "compact, stiff cave soil" with "crusts" and ashy areas dispersed from 1.5 to 3.6 m below the surface (Bruce Howe, personal communication 1991). The "crusts" appear to be similar to calcareous features found at Shanidar (Solecki and Solecki 1993) and Karain Cave (Otte et al. 1995; Yalcinkaya et al. 1993:102). There are also episodes of rockfall in the Mousterian deposits at approximately level P and at the base of the excavated deposit in levels CC/DD. It is possible the calcareous "crusts" and the rockfall episodes can be used to "date" various levels at these sites in terms of environmental conditions (see Chapter 3).

The lithic assemblage has, until now, never been analyzed in detail. The assemblage is composed of tools, flakes, trimming flakes, shatter, and cores (Figure 25). Seventeen Mousterian artifacts deposited at the Musée Iran Bastan (Tehran)—three small discoid cores, eight Mousterian points, and six sidescrapers—are not included in this study

Kunji

This cave site is located in the Khorramabad Valley approximately 6 km from the town of Khorramabad at an elevation of 1,300 m. The cave provides an excellent view of the valley below and also of Gar Arjeneh

situated on a knoll 1.5 km away. Kunji was discovered by Henry Field (1951) and excavated by Hole and Flannery in 1963. A 1 by 10 m test trench was excavated, exposing Mousterian deposits under approximately 1 m of Uruk period ceramic layers. The Mousterian industry was labeled "late" and described as "non-Levallois" (Hole and Flannery 1967).

In 1969, John Speth, then a graduate student at the University of Michigan, returned to Kunji to do a spatial analysis of activities on the "living floors" (Speth 1971). He found that the site was heavily disturbed by rodent and porcupine burrows and estimated that less than one-third of the Mousterian deposits were intact (Baumler and Speth 1993:2). Fortuitously, Hole and Flannery's test excavation was located in an undisturbed portion of the site. They had found 12 natural stratigraphic layers divided into three major groups: (1) 0–1.0 m contained ceramic period deposits, architectural features, and some Mousterian artifacts mixed in at the base; (2) 1.0–1.3 m to 1.4 m was composed of a fine-grained sediment with Mousterian artifacts, ashy lenses, and faunal remains; and (3) 1.3–1.4 m to 2.0–2.2 m consisted of a coarse-grained sediment containing limestone fragments and rockfall, and relatively fewer lithic artifacts, bones, or evidence of fire. Apparently, there was evidence in isolated brecciated deposits on the walls of the cave for an Upper and/or Epipaleolithic occupation of Kunji, but these remains had been removed by erosion. A thin layer of reddish brown, "water laid" clay capped the Mousterian deposits and contained fragments of stalactites, and chunks of this breccia contained bladelets, debitage, and animal bones.

Speth's excavation recovered 2,713 lithic pieces, of which 2,639 were analyzed in 1970 by Speth and in 1985 and 1986 by Baumler. Baumler and Speth's (1993:20) analysis emphasizes the intensity of reduction in the assemblage with many of the scrapers having been utilized to a similar, final size that suggests they were no longer functional (Figure 8). However, they contend that the recovered scrapers do not conform entirely to Dibble's scraper reduction model (1984a, 1987a, 1987b, 1988, 1995b; and see Chapter 6). They also noted few cores or evidence for core reduction at Kunji, suggesting for the most part that flakes and/or tools were being transported to the cave from other areas, rather than being manufactured there. The lack of core reduction at the cave is different from other Zagros Mousterian sites and suggests more variability in the movement of raw material and finished tools around the landscape than previously observed.

Gar Arjeneh

This rockshelter is located in the Khorramabad Valley in southwestern Iran at an elevation of approximately 1,200 m and 1.5 km from the site of Kunji (Hole and Flannery 1967). The site is located on a remnant "island" of land that rises above the valley floor. It was excavated by Hole and Flannery in 1963 and contained both Mousterian and Baradostian deposits that were disturbed by porcupine burrowing. The site has been labeled a "butchering station" because the deposit contained faunal remains that suggested to the excavators "brief episodes of consumption." The lithic collection from Gar Arjeneh was not included in the initial analysis of the Khorramabad Mousterian because some levels had been disturbed by porcupine burrows and because of possible mixing of the Middle and Upper Paleolithic layers. An initial examination by the author of the material at Yale suggested a minimal amount of mixing and the presence of a "classic" Zagros Mousterian assemblage.

Summary

Of the seven sites chosen for this study, only three, Bisitun, Kunji (Hole and Flannery's 1963 collection), and Warwasi, have been analyzed in any detail. The recent Kunji analysis was on material not available for that study (Baumler and Speth 1993). Barda Balka, Gar Arjeneh, and Shanidar have been reported on but no detailed analysis has been published. Kobeh has not been described until now.

Of the seven sites, Bisitun (535 pieces analyzed in this study) and Warwasi (1,485 pieces analyzed in this study) stand apart in the sheer number of artifacts recovered from the excavations (13,000 and 15,350, respectively) relative to other Zagros Mousterian sites. In comparison, Barda Balka (flake industry only analysed in this study) has 3,167 pieces inclusive of "shatter"; Gar Arjeneh, 293 pieces; Kobeh, 2,855 pieces; Kunji, 238 from 1963/1965 and 2,713 from 1969; and Shanidar has over 1,000 pieces in Iraq and the US available for analysis.

The representativeness of each of these studied samples, as compared with the total population of lithics at each site, is unknown at this time. Test excavations at Barda Balka, Shanidar, Bisitun, Warwasi, Kobeh, Kunji, and Gar Arjeneh constituted different percentages of the total area at each site. In addition, the excavated depth was different at each site. To exacerbate this problem, several excavators disposed of large amounts of debitage or "scrap," while others saved everything that was excavated. We are left with seven sites that have different sample sizes of variable quality.

Be that as it may, the analysis of old collections can produce viable results, and analyses such as these will become more common as regions are closed to further archaeological research. Sample size and representativeness are important considerations but should not affect the overall analysis of data, especially if nonparametric statistics are used. In this way, the assumption of normality for metric attribute distribution within these populations can be avoided.

9

Results of the Analysis

Chapter 7 outlined the variables to be analyzed for flakes, tools, and cores, and how the analyses would proceed. This chapter presents the results of the analysis.

Flakes

Table 5 shows the number of whole flakes over 2 cm and those less than 2 cm in maximum dimension, tools, tool fragments, flake fragments, cores, and core fragments noted at each site. Only whole flakes over 2 cm are analyzed, and these are differentiated in Table 6 by dorsal scar pattern. Centripetal flakes are those with a radial flaking pattern and include various blank types that are called Levallois. Longitudinal flakes are those that show either unidirectional or bidirectional flaking on the dorsal surface. Cortical flakes have >50% cortex still present on the dorsal surface.

The angle of skew values for whole flakes at each site were very similar, as was cortex placement (primarily grid areas 2 and 3) and flake scar placement (dominated by grid area 1, even for centripetal blanks). This regularity suggests that each core was addressed in a similar way throughout each reduction sequence at every site. Such regional consistency in technology implies that something was impinging on the reduction process, such as raw material size and shape or "tradition."

Barda Balka

The flake sample from Barda Balka is divided into a fine-grained and a coarse-grained group. Every whole flake collected by the excavators was analyzed. The fine-grained sample comprised flakes made of green, red, brown, etc., radiolarite, which is a fairly ubiquitous material found throughout the region in the form of small pebbles in stream gravels. The coarse-grained group is primarily made from quartzite. The clear size difference between the two categories is demonstrated by the much larger coarse-grained pieces. I separated the quartzite pieces from the fine-grained component in order to assess differential treatment of raw material and whether there are similar processes acting on both groups. Unfortunately, Barda Balka is one of only two sites (along with Warwasi) analyzed for this study that have a significant component of coarse-grained raw material. The coarse-grained component from the later Kunji excavation (Baumler and Speth 1993) was not available for this study, but it consisted of only 40 limestone artifacts.

Fine-Grained Material

The 275 whole flakes analyzed from the fine-grained component are dominated by blanks with a longitudinally oriented flaking technique composed of flakes with both single or double opposed platforms (Table 6). The centripetal flaking technique is rare, constituting only 15% of the flakes in the sample. Nevertheless, the fine-grained component at this site has a higher percentage of centripetal flakes than any other site analyzed in this study.

Results of a Mann-Whimey U test indicate that longitudinal flakes are significantly longer than centripetal flakes, but not wider or thicker (Table 7). These longer flakes could have been removed earlier in the reduction sequence before any centripetal flakes (e.g., Baumler 1988). In partial support of this conclusion, longitudinal flakes have, on the average, a higher incidence of cortex remaining on them than centripetal flakes. Only 62% of longitudinal flakes are totally non-cortical whereas 91% of centripetal flakes are cortex free (Table 8).

Cortical flakes (flakes with >50% cortex on their dorsal surface) are significantly larger than both centripetal and longitudinal flakes, suggesting the processing of at least some relatively complete fine-grained cores on site (Table 7). However, platform width and thickness are statistically similar for all types of flakes, suggesting all these flakes may have originally been nearly the same size. The location of cortex on flake blanks is the same for both longitudinal and centripetal flakes, but the amount of cortex left on these blanks is very different (Table 8). Longitudinal flakes have a higher percentage of flakes with a greater amount of cortex than centripetal flakes.

Platforms on all blanks are dominated by the plain type, with dihedral, multiple retouched, and cortical platforms all being present at <10% each (Table 9). When subdivided into the two flake types of interest here (centripetal and longitudinal), the only differences are the greater number of dihedral platforms on centripetal flakes and more cortical platforms on longitudinal flakes (Table 10). The percentage of plain platforms is nearly identical between the two groups.

Table 5. Artifact counts for the Zagros Middle Paleolithic sites used in this study.

Site	Whole Flakes	Tools	Tool Fragments	Flakes <2 cm	Flake Fragments	Cores	Core Fragments
Barda Balka, fine-grained	275	195	64	1,604	n/a	187	319
Barda Balka, coarse-grained	244	92	n/a	n/a	n/a	50	n/a
Shanidar	121	48	n/a	n/a	n/a	1	n/a
Bisitun	111	245	n/a	n/a	n/a	111	38
Kobeh	506	386	583	165	846	148	146
Warwasi (all)	823	127	161	257	597	241	107
Kunji	42	158	n/a	n/a	n/a	15	n/a
Gar Arjeneh	93	143	n/a	n/a	n/a	35	n/a

Coarse-Grained Material

The 244 coarse-grained flakes are also dominated by longitudinal flakes (Table 6). Centripetally flaked blanks are rare. The number of flakes classified as having "no pattern" is high owing to the difficulty of determining the direction of flaking on quartzite and will not be referred to further in this analysis.

There is no significant difference in size between centripetal and longitudinal flakes (Table 7). However, there is a significant size difference between these flakes and cortical flakes. Again, it appears that the larger cortical flakes were removed earlier in the reduction sequence. There are no significant differences in platform size between any of these flake blanks except for the significantly thicker platforms of cortical flakes compared with longitudinal flakes.

The platforms in this sample are dominated by plain types but with a somewhat higher percentage of cortical platforms, dihedral, and multiple retouched types than in the fine-grained sample (Table 9). Centripetal blanks have a lower number of plain platforms and a higher number of multiple retouched platforms than longitudinal flakes. Longitudinal flakes also have a greater number of cortical platforms; the same pattern was found in the fine-grained component (Table 10). These data suggest that longitudinal flakes were removed at early stages in the reduction process, whereas centripetal flakes were not.

Bisitun

A sample of 115 whole flakes was selected from the Bisitun collection to compare with findings of the study by Dibble (1984b). The collection, housed at the University of Pennsylvania, is a highly selected sample collected by Coon. Using a Mann-Whitney U test, I found that centripetal flakes are significantly larger than longitudinal flakes in every dimension, including platform width and thickness (Table 7). The presence of only four flakes with any cortex precludes statistical analysis because of small sample size. However, the mean length of cortical flakes at Bisitun is larger than the means of either the centripetal or longitudinal sample. It is clear that the centripetal component was flaked from larger core material, but it is not possible at this time to determine whether these flakes came from the same cores as longitudinal flakes but earlier in the reduction sequence or were produced from different core material. We cannot be certain how the selective nature of the collection is affecting this difference. In the Bisitun sample, multiple retouched platforms are most common (Table 9). However, if the two flake types are compared it is apparent that centripetal flakes have a much higher incidence of faceted platforms (Table 10). Again, this could be due to the selective nature of the sample.

Dibble (1984b) found a greater frequency of Levallois technique at Bisitun than previously reported (i.e., Skinner 1965). He also noted that most of the debitage is uni- or bidirectional (longitudinal) flakes that are similar in size to the scrapers at the site. I have used a more conservative approach by identifying centripetal flakes rather than Levallois. The presence of these flakes does appear to reflect a change in the reduction strategy utilized at Bisitun.

Gar Arjeneh

This study analyzed 93 complete flakes from Gar Arjeneh (Table 6). There are only two centripetal flakes, precluding any statistical comparisons between these flakes and longitudinal flakes. However, a cursory examination of all the flakes shows very little size difference between longitudinal and centripetal types but an interesting difference in size between centripetal and cortical flakes that the small sample size makes it difficult to evaluate (Table 7). Cortical flakes are longer but narrower than centripetal flakes, suggesting the possibility of being flaked from different core material. Cortical flakes are longer and thicker than longitudinal flakes but not wider; the small sample will not allow a statistical confirmation.

The small centripetal sample has no cortex at all on the dorsal surface, whereas 50% of longitudinal flakes have some cortex left on the flake (Table 8). Faceted platforms are by far the most common at this site for both types of flake blanks (Table 10).

Table 6. Mean whole flake measurements (in mm) by site and flake type (as distinguished by dorsal scar pattern).

Site/	Whole Flakes		Length		Width		Thickness		Platform Width		Platform Thickness	
Flake Type	N	%	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
Barda Balka												
fine-grained												
Centripetal	41	15	25.5	11.0	24.2	7.7	6.4	2.4	18.3	9.7	4.9	2.5
Longitudinal	199	72	29.5	11.5	22.4	8.1	6.8	2.9	16.2	8.5	5.4	3.0
Cortical	16	6	34.5	11.8	28.6	7.9	10.3	4.7	18.3	8.1	5.3	2.7
Irregular	19	7	28.6	6.7	20.6	6.7	6.9	2.9	14.8	7.9	5.9	2.6
Barda Balka												
coarse-grained												
Centripetal	16	7	37.5	11.1	30.8	12.0	10.1	3.9	21.8	10.6	7.3	3.4
Longitudinal	142	58	38.0	13.2	28.3	9.0	9.3	3.9	19.6	8.2	6.7	3.3
Cortical	66	27	46.4	18.4	38.1	15.5	12.9	5.4	22.4	13.4	7.3	4.7
Irregular	20	8	39.5	13.4	26.9	10.7	9.6	4.6	18.7	8.9	7.2	3.4
Shanidar												
Centripetal	7	6	32.4	9.3	22.4	4.2	4.6	1.5	13.6	5.5	4.6	1.8
Longitudinal	104	86	34.4	12.2	20.5	7.2	4.8	2.2	12.1	7.3	3.7	2.4
Cortical	4	3	42.1	4.9	25.7	5.8	7.8	3.3	8.2	6.9	3.3	3.3
Irregular	6	5	36.4	6.4	18.8	5.7	6.5	2.1	10.9	7.4	3.1	0.9
Bisitun												
Centripetal	16	14	55.5	18.2	35.5	15.1	7.7	3.4	23.9	18.3	5.6	2.7
Longitudinal	83	75	44.6	16.1	21.8	8.4	5.2	2.1	13.3	7.7	3.6	2.0
Cortical	4	4	56.0	7.7	24.6	11.5	8.9	2.9	12.2	3.3	5.0	2.0
Irregular	8	7	35.1	16.1	19.5	6.1	6.0	2.4	12.4	3.3	4.7	1.8
Kobeh												
Centripetal	26	5	35.3	8.6	25.1	5.9	4.7	1.2	15.5	7.3	4.1	1.6
Longitudinal	399	79	33.2	8.0	21.0	6.2	5.3	2.4	12.7	6.7	4.0	2.1
Cortical	26	5	34.1	10.4	25.5	7.2	6.8	2.7	13.4	5.7	4.2	2.0
Irregular	55	11	33.2	8.2	31.8	8.4	6.6	2.8	12.2	5.8	4.8	2.6
Warwasi												
fine-grained												
Centripetal	62	9	30.1	8.6	21.6	6.5	4.7	2.3	13.3	6.8	3.5	2.1
Longitudinal	552	81	33.1	10.3	19.1	7.2	4.4	2.0	11.8	7.1	3.4	2.1
Cortical	14	2	38.2	16.1	21.4	10.1	7.0	4.8	11.6	6.2	3.9	1.6
Irregular	55	8	31.2	9.3	19.5	7.1	5.5	3.0	12.0	7.2	3.3	1.6
Warwasi												
coarse-grained												
Centripetal	9	6	40.6	16.7	31.8	13.4	7.7	3.0	22.3	17.1	5.8	3.7
Longitudinal	104	74	34.6	11.8	23.3	7.8	5.6	2.4	15.5	8.3	4.5	2.3
Cortical	11	8	42.9	17.7	28.5	13.1	7.4	4.0	16.6	10.0	4.8	3.1
Irregular	16	11	37.4	10.6	23.9	12.5	6.6	2.8	15.9	9.1	4.3	2.9
Kunji												
Centripetal	2	5	31.2	6.9	22.9	2.8	4.6	1.5	13.0	6.2	4.2	0.02
Longitudinal	33	79	45.2	12.1	25.1	7.7	5.6	2.1	14.9	7.5	4.3	1.5
Cortical	3	7	37.5	14.1	28.1	5.2	6.5	3.2	20.7	6.7	4.3	0.6
Irregular	4	9	44.8	9.1	22.5	3.9	7.2	1.5	8.1	4.3	3.7	1.7
Gar Arjeneh												
Centripetal	2	2	33.1	3.5	23.4	3.6	5.6	1.3	16.8	4.2	3.7	0.4
Longitudinal	83	89	36.0	9.1	23.7	6.1	5.6	2.1	16.1	7.1	5.2	2.1
Cortical	4	4	44.2	7.3	19.4	1.5	7.3	2.8	15.0	4.2	5.2	1.3
Irregular	4	4	32.9	7.2	25.5	6.5	7.7	4.5	14.4	4.7	4.7	2.2

Table 7. Mann-Whitney U test probability values for flake measurements by site and flake type.

Flake Type	Sample Size N_1	Sample Size N_2	Length	Width	Thickness	Platform Width	Platform Thickness	Flake Area
Barda Balka fine-grained								
Cent/Long	42	210	0.01	0.19	0.15	0.27	0.23	0.29
Cent/Cort	42	5	*	*	*	*	*	*
Long/Cort	210	5	*	*	*	*	*	*
Barda Balka coarse-grained								
Cent/Long	16	163	0.92	0.76	0.58	0.56	0.53	0.88
Cent/Cort	16	42	0.06	0.04	0.1	0.73	0.3	0.03
Long/Cort	163	42	0.009	0.001	0.001	0.84	0.46	0.001
Bisitun								
Cent/Long	16	87	0.03	0.001	0.004	0.02	0.004	
Cent/Cort	16	4	*	*	*	*	*	*
Long/Cort	87	4	*	*	*	*	*	*
Gar Arjeneh								
Cent/Long	2	84	*	*	*	*	*	*
Cent/Cort	2	3	*	*	*	*	*	*
Long/Cort	84	3	*	*	*	*	*	*
Kobeh								
Cent/Long	26	413	0.28	0.001	0.36	0.03	0.39	0.003
Cent/Cort	26	9	0.71	0.35	0.05	0.33	0.41	0.94
Long/Cort	413	9	0.73	0.02	0.17	0.02	0.23	0.08
Kunji								
Cent/Long	2	33	*	*	*	*	*	*
Cent/Cort	2	3	*	*	*	*	*	*
Long/Cort	33	3	*	*	*	*	*	*
Shanidar								
Cent/Long	7	105	0.74	0.27	0.94	0.41	0.15	0.58
Cent/Cort	7	3	*	*	*	*	*	*
Long/Cort	105	3	*	*	*	*	*	*
Warwasi fine-grained								
Cent/Long	62	561	0.15	0.002	0.38	0.03	0.73	0.18
Cent/Cort	62	14	0.2	0.49	0.04	0.41	0.26	*
Long/Cort	552	14	0.44	0.49	0.008	0.9	0.13	0.78
Warwasi coarse-grained								
Cent/Long	9	108	0.29	0.02	0.02	0.14	0.27	0.03
Cent/Cort	9	11	0.85	0.38	0.52	0.38	0.62	*
Long/Cort	108	3	*	*	*	*	*	*

* denotes sample size too small for analysis

The lack of centripetally flaked blanks at Gar Arjeneh suggests these blanks were not made at this location, were not collected with this sample, were not discarded in the area of the site that was excavated, or were reduced to such an extent as to be unrecognizable. The greater length of the few cortical flakes recovered suggests at least some of the local pebble raw material was processed at the site.

Kobeh

All 506 whole flakes recovered from the excavation at Kobeh were analyzed (Table 6). The Mann-Whitney U test indicates the primary size difference between longitudinal and centripetal flakes is in the significantly greater width of the latter type (Table 7), although the mean length is also greater. This translates into a greater overall flake size and platform width as well. There are, however, only 26 centripetal flakes in this collection. The main difference here between centripetal and cortical flakes is in thickness, with the latter being significantly thicker but not greater in size. Cortical flakes are significantly different in width and platform width, which translates into a greater overall flaking platform size than for longitudinal-type flakes. Platforms

Table 8. Percentage cortex by flake type.

	None		≤25%		≥26%	
	N	%	N	%	N	%
Barda Balka fine-grained						
Longitudinal	106	62	34	20	30	18
Centripetal	38	91	3	7	1	2
Barda Balka coarse-grained						
Longitudinal	62	51	25	20	35	29
Centripetal	15	94	0	—	1	6
Shanidar						
Longitudinal	51	74	14	20	4	6
Centripetal	4	57	3	43	0	—
Bisitun						
Longitudinal	54	76	12	17	5	7
Centripetal	11	69	4	25	1	6
Warwasi fine-grained						
Longitudinal	421	75	96	17	43	8
Centripetal	58	94	4	6	0	—
Warwasi coarse-grained						
Longitudinal	69	94	26	24	13	12
Centripetal	8	89	1	11	0	—
Kobeh						
Longitudinal	201	70	53	19	30	11
Centripetal	24	92	2	8	0	—
Kunji						
Longitudinal	16	76	3	14	2	10
Centripetal	1	50	1	50	0	—
Gar Arjeneh						
Longitudinal	32	52	25	40	5	8
Centripetal	2	100	0	—	0	—

Table 9. Platform types for whole flakes by site.

	Whole Flakes	Plain		Dihedral		Faceted		Cortical		Other	
Site	N	N	%	N	%	N	%	N	%	N	%
Barda Balka fine-grained	275	185	67	24	9	25	9	19	7	22	8
Barda Balka coarse-grained	244	138	57	28	11	30	12	42	18	6	2
Shanidar	121	35	29	10	8	46	38	6	5	24	20
Bisitun	111	35	32	19	17	43	39	7	6	7	6
Kobeh	506	188	37	68	13	171	34	22	4	57	11
Warwasi fine-grained	623	196	31	112	18	243	39	15	2	57	10
Warwasi coarse-grained	117	45	38	20	17	44	38	4	3	4	3
Kunji	42	16	38	3	7	18	43	2	5	3	7
Gar Arjeneh	93	19	20	8	9	55	59	6	7	5	5

are either plain or faceted (Table 9). Centripetal flakes have no cortical platforms and more faceted platforms than longitudinal flakes do (Table 10).

The larger overall size (length by width) of centripetal flakes coupled with the lack of cortical platforms might indicate these flakes were not manufactured at Kobeh. The presence of only 26 of these blanks out of more than 700 flakes in the assemblage demonstrates a lack of commitment to their production on site or at least to their discard at the site. Along these

Table 10. Platform preparation by flake type.

Site/Flake Type	Total	Plain		Dihedral		Faceted		Cortical		Other	
		N	%	N	%	N	%	N	%	N	%
Barda Balka fine-grained											
Centripetal	42	29	69	8	19	4	10	0	—	1	2
Longitudinal	210	139	66	14	7	18	9	18	9	21	10
Cortical	5	4	80	0	—	0	—	1	20	0	—
Barda Balka coarse-grained											
Centripetal	16	7	44	3	19	5	31	1	6	0	—
Longitudinal	163	100	61	19	12	21	13	19	12	4	2
Cortical	42	16	38	4	10	2	5	18	43	2	5
Bisitun											
Centripetal	16	4	25	0	—	10	63	1	6	1	6
Longitudinal	76	23	30	16	21	28	37	3	4	6	8
Cortical	0	0	—	0	—	0	—	0	—	0	—
Gar Arjeneh											
Centripetal	2	1	50	0	—	1	50	0	—	0	—
Longitudinal	84	16	19	8	10	50	60	6	7	4	5
Cortical	3	1	33	0	—	2	67	0	—	0	—
Kobeh											
Centripetal	26	3	12	4	15	17	65	0	—	2	8
Longitudinal	413	158	38	56	14	138	33	18	4	43	11
Cortical	9	1	11	3	33	5	56	0	—	0	—
Kunji											
Centripetal	2	0	—	0	—	2	100	0	—	0	—
Longitudinal	33	13	39	3	9	14	42	1	3	2	7
Cortical	1	0	—	0	—	1	100	0	—	0	—
Shanidar											
Centripetal	7	1	14	1	14	5	72	0	—	0	—
Longitudinal	105	32	31	9	9	38	36	5	5	21	19
Cortical	3	1	33	0	—	1	33	1	33	0	—
Warwasi fine-grained											
Centripetal	62	20	32	10	16	28	45	0	—	4	7
Longitudinal	561	176	31	102	18	215	38	15	3	53	9
Cortical	4	2	50	0	—	0	—	1	25	1	25
Warwasi coarse-grained											
Centripetal	9	2	22	2	22	5	56	0	—	0	—
Longitudinal	108	43	40	18	17	39	36	4	4	4	4
Cortical	3	2	67	0	—	0	—	1	33	0	—

lines, the core analysis (see below) shows that 12% of the total cores are centripetal types, which is more than one might expect given the small number of removals left on site. This gives some credence to the suggestion that centripetal flakes (and cores) could have been carried from the site area, or that many of the removals from centripetal cores fall under the 2 cm size limit.

Kunji

Only 42 whole flakes from the 1963 excavations at Kunji are available for study (Table 6). Statistical analysis was not done as there are only two centripetal flakes and one cortical flake. However, an examination of the means (Table 6) shows that longitudinal flakes are longer and wider than centripetal flakes. Cortical flakes are longer than centripetal flakes and wider than both other flake types. The two centripetal flakes have faceted platforms while the longitudinal flakes are nearly equally divided among plain and faceted platforms (Table 10).

Baumler and Speth (1993:26) list only 38 cortical flakes from their analysis, with 407 additional flakes having at least some cortex on the dorsal surface. There are 64 Levallois flakes in the 1969 sample, but the size data could not be compared with the cortical or non-

cortical flake component since no measurements were listed.

Shanidar

I studied a sample of 121 whole flakes from Shanidar (Table 6). Based on a Mann-Whitney U test there are no significant size differences between centripetal and longitudinal flake blanks (Table 7), although the sample size of centripetal flakes is only adequate. If means are examined, centripetal flakes are shorter and wider than longitudinal flakes. In addition, cortical flakes are markedly thicker, on average, than centripetal blanks but not quite longer ($\alpha > .05$), and in a larger sample this relationship would show a significant difference. There is, however, a significant difference between longitudinal and cortical flakes, in terms of the latter being greater in both length and thickness (Table 7).

The platforms on centripetal flakes are primarily faceted, while those on longitudinal flakes are nearly equally divided between plain and faceted types (Table 10).

Owing to limitations imposed by the small sample, it is difficult to infer much from these data. Longitudinal flakes are smaller than cortical flakes and have a greater frequency of cortical platforms and percentage of cortex remaining on the exterior surface, indicating they were produced both early and late in the reduction sequence at the site. Centripetal flakes are smaller than both cortical and longitudinal flakes and show little cortex or cortical platforms. This appears to indicate that these blanks might have been produced later in the same reduction sequence as the longitudinal and the cortical flakes but their small numbers seem to indicate they were being transported elsewhere as well.

Warwasi

Of the 823 complete flakes analyzed from the Warwasi collection, 628 are fine-grained material and 124 are coarse-grained. These two categories do not include 71 flakes that were classified as irregular. There are only 25 whole cortical flakes (>50% of dorsal surface).

Fine-Grained Material

In the fine-grained component from Warwasi there is no statistically significant difference in overall flake area between centripetal and cortical flakes (Table 7). However, cortical flakes appear, on the average, longer and thicker than centripetal flakes. Centripetal and longitudinal flakes have different widths and platform widths. Longitudinal flakes are not significantly different from cortical flakes in all dimensions except thickness. Yet, cortical flakes have greater average lengths. This finding is similar to those for other sites analyzed in this study that contained longitudinal flakes that were, on the average, smaller than the cortical sample.

Platform preparation is composed primarily of both plain and faceted platforms for both longitudinal-type and centripetal-type flakes (Table 10). This contrasts with the finding at other sites where centripetal flakes have primarily faceted platforms to the exclusion of all other types (Table 10).

Coarse-Grained Material

The coarse-grained component contains centripetal flakes that, based on results of a Mann-Whitney U test statistic, are significantly larger than longitudinal flakes, primarily in width and thickness (Table 7). However, the mean length, width, and thickness of centripetal flakes are all larger than for longitudinal flakes. Cortical flakes are longer than longitudinal flakes but not wider or thicker. Centripetal flakes are shorter than cortical flakes but are also wider and thicker (Table 7) and show almost no cortex at all on the dorsal surfaces (Table 8). Longitudinal flakes show the complete range of cortex cover from none to almost 50% (cortical flake boundary). The platform preparation for centripetal flakes is primarily faceted, but there are nearly as many plain and dihedral platforms as well (Table 10). Longitudinal type flakes have a characteristic Zagros pattern of nearly equal numbers of both plain and faceted platforms (Table 10). In addition, longitudinal flakes have cortical platforms in both the coarse and fine-grained components. No cortical platforms are present on any centripetal flakes.

Summary for Flakes

Centripetal-type flakes form a relatively small component of the Zagros flake samples analyzed. However, these flakes are different enough in overall size and treatment to be considered as a separate stage in the reduction trajectories from the longitudinal flakes recovered from the same sites.

There are no overall significant differences between centripetal and longitudinal flakes at Gar Arjeneh, Kunji, and Shanidar. However, the mean measurements show longitudinal flakes to be slightly longer and wider at Gar Arjeneh and Kunji, while being only longer at Shanidar (Table 6). Only at Barda Balka, in the fine-grained component, are longitudinal flakes significantly longer than centripetal flakes. In six of the nine assemblages and subassemblages, centripetal flakes are shorter than longitudinal flakes. In the Warwasi coarse-grained materials, and at Bisitun and Kobeh, this pattern is reversed. Bisitun can be dismissed owing to selection problems with Coon's sample. The larger longitudinal flakes at Kobeh and in the Warwasi coarse-grained subassemblage were "removed" by the inhabitants of these sites, who used them as tools and resharpened them.

Cortical flakes are larger than longitudinal flakes at every site except Kunji and longer than centripetal flakes at every site but Kobeh. Mean size data show cortical

flakes are wider in both fine- and coarse-grained components from Barda Balka and at Kobeh. The width of these blanks is nearly equal at Warwasi among fine-grained materials.

From these data, it could be argued that longitudinal flakes were more than likely manufactured on site at every Zagros site studied. In addition, in eight of nine assemblages the mean length for cortical flakes is larger than the mean length for longitudinal flakes (89%). Region wide, cortical flake length is related to, or predicts, longitudinal flake length (R = .88). Only at Kunji are longitudinal flakes larger than cortical flakes. However, the Kunji sample is quite small. The presence of a range of cortex on longitudinal flakes along with numerous cortical platforms strengthens this conclusion.

On a region-wide basis, longitudinal flake length predicts centripetal flake length (R = .79). This suggests that the centripetal flakes at most of the sites in the Zagros belong to the same reduction trajectory, following the Baumler model (1988). Centripetal flakes were either not produced in quantity at Kobeh, Warwasi (coarse flakes), and Bisitun or they were transported off site after production. As will be seen in the tool section below, very small percentages of tools in these assemblages can be attributed to centripetal blanks. At Kobeh, the fact that flakes in the centripetal flake sample are longer and wider than platform flakes, similar in size to cortical flakes, show almost no cortex on the dorsal surfaces, and lack cortical platforms indicates that they were probably not part of the same production sequence that produced the other flakes at the site.

Tools

The tool assemblages from the Zagros are known for being dominated by heavily reduced points and scrapers (Baumler and Speth 1993; Bewley 1984; Dibble 1984b; Dibble and Holdaway 1993; Hole and Flannery 1967; Skinner 1965; Solecki and Solecki 1993). Although these observations are confirmed by this study, there is a good deal of variability within all this reduction.

Barda Balka

Barda Balka has both a fine-grained and a coarse-grained component in the tool assemblage and I analyzed each separately. This site is interesting because it has the highest retouched edge reduction indices for scrapers among all the sites (Table 11) but the least number of so-called highly reduced types (i.e., double and convergent scrapers) common to the other sites (Table 12). The assemblage is dominated by denticulates and also single-edged scrapers that are heavily retouched. There is a much smaller percentage of transverse and dejeté forms, as well. This single to transverse reduction model is rare at other Zagros Mousterian sites. Dibble (1995a) has suggested that a preponderance of single scrapers in an assemblage might indicate blanks that are naturally backed, causing one edge to be resharpened more intensely. The data from Barda Balka shows 41% of single scrapers have >25% cortex remaining on the dorsal surface. This is the highest percentage of all the sites analyzed, although the cortex is located in all four quadrants on the tools (Table 13; Figure 16). These data appear to support Dibble's assertion; however, the data do not confirm whether these pieces were naturally backed.

In addition, 41% of all the formal tools are notched pieces and denticulates. This is by far the largest percentage of these tool types at any Zagros Mousterian site.

Fine-Grained Material

The fine-grained tool assemblage is made of the same radiolarite pebbles found at other Zagros sites and

Table 11. Mean retouch intensity values for scrapers by site.

	Single Scraper	Double Scraper	Convergent† Scraper	Dejeté Scraper	Transverse Scraper
Barda Balka fine-grained	0.899	0.889	—	0.909	0.956
Barda Balka coarse-grained	0.909	—	—	—	0.956
Shanidar	0.846	0.89	0.896	0.839	I
Bisitun	0.771	0.77	0.826	0.798	0.895
Kobeh	0.838	0.861	0.872	0.9	0.879
Warwasi fine-grained	0.841	0.849	0.871	0.859	0.754
Warwasi coarse-grained	—	—	—	—	—
Kunji	0.816	0.833	0.803	0.836	0.826
Gar Arjeneh	0.832	0.856	0.884	0.885	0.89

† includes Mousterian points

Note: Blank cells indicate insufficient sample size for analysis.

Table 12. Tool counts and percentages by site.

	Single Scraper		Double Scraper		Convergent† Scraper		Dejeté Scraper		Transverse Scraper		Denticulate‡		Naturally Backed		Ventral/ Inverse Scraper	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Barda Balka fine-grained	44	22	3	1.5	1	0.5	2	1	18	9	94	48	12	6	21	10
Barda Balka coarse-grained	20	21	0	—	1	0.5	2	2	6	7	49	53	10	10	4	4.5
Shanidar	12	25	8	17	15	31	2	4	1	2	9	19	1	2	0	—
Bisitun	83	33	48	20	95	39	9	4	2	1	3	1	5	2	0	—
Kobeh	147	38	69	18	103	27	19	5	15	4	29	8	4	1	0	—
Warwasi fine-grained	42	37	16	14	16	14	4	3.5	2	1.5	24	21	9	8	0	—
Warwasi coarse-grained	5	36	0	—	0	—	0	—	1	7	5	36	3	21	0	—
Kunji	100	63	17	11	9	6	14	9	7	4	6	4	5	3	0	—
Gar Arjeneh	69	48	13	9	32	22	16	11	9	7	2	1	2	1	0	—

† Includes Mousterian points
‡ Includes notches

is composed of 195 whole tools, with the majority of the tools being denticulates/notches, followed in frequency by single scrapers, ventral scrapers, transverse types, naturally backed pieces, miscellaneous retouched pieces, and double, convergent, and dejeté scrapers (Table 12). Centripetal blanks were made into 15% of the tools recovered with 1% of the tools on cortical blanks and 84% on longitudinal blanks.

Centripetal blanks are made into denticulates/notched pieces (59%), single scrapers (19%), transverse scrapers (19%), and ventral scrapers (3%). All three cortical flakes were made into single scrapers. Longitudinal flakes are composed of 58% denticulates, 21% single scrapers, 10% transverse scrapers, 10% ventral scrapers, 1% double scrapers, and <1% convergent scrapers.

Single scrapers are, on the average, smaller than double scrapers, although there are only three double scrapers in the sample (Table 14; also see the Appendix). The sample of three double and one convergent scrapers is too small to attempt any additional size comparisons for this site. Transverse scrapers have, in general, a smaller overall flake area but similar platform area as single scrapers but are significantly shorter and on average wider than the single scrapers in the sample. The width and thickness of these two types are not significantly different, but the Mann-Whitney U test probability values are close (χ approximation = 2.857, df = 1, p = .09, and χ = 3.017, df – 1, p = .08, respectively). In addition, transverse scrapers have a greater retouch intensity value than single scrapers (.956 versus .898) which is significant at the .01 level (Table 11). Inverse scrapers were only noted at Barda Balka, and they are statistically the same in every dimension to single scrapers. The retouch intensity index used in this thesis (see also Kuhn 1990b) cannot be applied to inversely retouched pieces so no measurements were collected. There are also no significant size differences between naturally backed (Bordes' type 38) and single scrapers. The single scrapers, inverse scrapers, naturally backed flakes, and retouched flakes from this site are all very similar in overall size, suggesting a similar lower size limit for tool discard.

The Mann-Whitney U test indicates that denticulates/notched pieces are significantly smaller than single scrapers (Appendix). There were no significant differences in length between notched pieces (type 42) and multiple notched pieces (type 43 denticulate), although the denticulates were significantly wider (p = .047). This evidence could possibly bolster the model of Holdaway et al. (1996) that denticulates (or multiple notched pieces) should be larger than notched pieces.

The amount of cortex on tools varies somewhat, with single scrapers having the greatest range of percentage of cortex and the smallest number of non-cortical pieces (Tables 13 and 15). Inverse scrapers had the next highest amount of non-cortical pieces followed by transverse scraper and denticulates.

Coarse-Grained Material

The coarse-grained tool assemblage, made of quartzite, includes 92 tools dominated (as with the fine-grained component) by denticulates/notched pieces followed by single scrapers, naturally backed pieces,

Table 13. Percentage of cortex (*N*) by tool type.

	None	≤ 50%	≥51%
Barda Balka fine			
Single scraper	21	17	6
Double scraper	2	1	0
Convergent	1	0	0
Transverse	10	6	2
Dejeté scraper	2	0	0
Denticulate	54	36	4
Ventral scraper	10	10	1
Barda Balka coarse			
Single scraper	10	9	1
Double scraper	0	0	0
Convergent	1	0	0
Transverse	4	2	0
Dejeté scraper	1	1	0
Denticulate	33	13	3
Ventral scraper	1	1	2
Shanidar			
Single scraper	7	5	0
Double scraper	8	0	0
Convergent	10	5	0
Transverse	1	0	0
Dejeté scraper	1	1	0
Denticulate	5	3	1
Ventral scraper	0	0	0
Bisitun			
Single scraper	55	25	3
Double scraper	36	12	0
Convergent	87	7	1
Transverse	2	0	0
Dejeté scraper	6	2	1
Denticulate	2	1	0
Ventral scraper	0	0	0
Warwasi fine			
Single scraper	32	15	2
Double scraper	16	1	0
Convergent	14	2	0
Transverse	3	0	0
Dejeté scraper	2	0	2
Denticulate	22	4	5
Ventral scraper	0	0	0
Warwasi coarse			
Single scraper	2	3	0
Double scraper	0	0	0
Convergent	0	0	0
Transverse	1	0	0
Dejeté scraper	0	0	0
Denticulate	0	3	0
Ventral scraper	0	0	0
Kobeh			
Single scraper	94	46	7
Double scraper	57	10	2
Convergent	71	12	1
Transverse	11	2	2
Dejeté scraper	17	2	0
Denticulate	23	5	1
Ventral scraper	0	0	0
Kunji			
Single scraper	51	38	11
Double scraper	12	5	0
Convergent	6	3	1
Transverse	6	0	1
Dejeté scraper	12	0	2
Denticulate	5	1	0
Ventral scraper	0	0	0
Gar Arjeneh			
Single scraper	28	33	8
Double scraper	7	3	3
Convergent	22	7	3
Transverse	5	2	2
Dejeté scraper	11	3	2
Denticulate	2	0	0
Ventral scraper	0	0	0

transverse scrapers, and inverse scrapers (Table 12). The percentages of tool types are almost identical to those for the fine-grained component. There are no double and only one convergent scrapers. In addition, there are no retouched pieces (Bordes' types 45–50).

In terms of the three flake types used in this study, 10% of the tools are manufactured on centripetal blanks, 8% on cortical blanks, and 82% on longitudinal blanks.

All of the centripetally flaked tool blanks are denticulates; 60% of cortical flakes are denticulates, while 20% are single scrapers and 20% are ventral scrapers. Longitudinal flakes are made into denticulates (47%), single scrapers (25%), transverse scrapers (8%), ventral scrapers (3%), and <1% dejeté scrapers.

There are no significant differences in size between single scrapers and denticulate/notched pieces in the coarse-grained sample, although single scrapers are longer on average (Table 14). Notched pieces (type 42) are not any different in size than denticulates (type 43) and are therefore combined for this study. This could be due to the presence of large and abundant raw material (Holdaway et al. 1996). Transverse scrapers are not significantly smaller than single types in overall flake area, but the mean value is smaller (Table 14). Transverse types have larger mean thickness and platform area (Table 14), but these differences are not significant at the .05 level. The mean values of retouch intensity for single and transverse types are different but not significantly, with transverse types having larger average values (Table 11). A larger sample size would clarify this relationship. Inverse scrapers are similar to single scrapers in overall size but on average are wider. As with the fine-grained sample, the retouch intensity index could not be calculated. Naturally backed pieces are also similar in size to single scrapers.

Table 14. Mean measurements for tools (in mm and mm^3) by site and tool type.

	Length	Width	Thickness	Platform Width	Platform Thickness	Flake Area	Platform Area
Barda Balka fine-grained							
Single scraper	39.8	26	10.6	17	5.9	1073.2	116.4
Double scraper	52.9	29.9	12.7	16.1	7.7	1607.8	126.7
Convergent	25.1	16.9	9.1	23.6	8.9	426.1	211
Transverse	27.5	29.4	9.3	15.7	5.4	825.3	103
Dejeté scraper	31.5	30.1	9.7	29.9	9.6	947.5	282.7
Denticulate	33.1	23.7	10.1	18.2	7	823	144.9
Ventral scraper	38.6	25.7	10.4	16.2	6.6	1028.8	129.1
Naturally backed	42.1	26.1	10.4	17.2	7.9	1210.4	162
Retouched piece	35.9	29.7	6.4	14.8	6.8	1080.4	99.9
Barda Balka coarse-grained							
Single scraper	46.7	27.6	11.1	17.4	7.4	1368.5	140
Double scraper	—	—	—	—	—	—	—
Convergent	—	—	—	—	—	—	—
Transverse	30.9	30.6	12.2	24	9.1	957	255.1
Dejeté scraper	39.9	28.5	13.2	23	8.4	1150.7	194.2
Denticulate	39.3	27.8	10.5	18.4	7	1135.9	148.7
Ventral scraper	44.2	34	12.7	26.1	9.9	1602.8	270.7
Naturally backed	43.3	23.9	8.9	13.9	6.8	1068.5	101.4
Retouched piece	33.9	28.8	11.5	19.8	8.6	1015.9	194.8
Shanidar							
Single scraper	49.9	22.1	6.5	13.4	4.7	1100.1	66.5
Double scraper	44.4	17.3	6.2	9.9	3.5	807.3	39.9
Convergent	43.6	17.7	7.5	11.8	4.4	783	67.7
Transverse	—	—	—	—	—	—	—
Dejeté scraper	35.7	19.6	7.7	4.5	2.5	701	22.8
Denticulate	46.8	20.1	6.1	14.2	4.6	957.9	79.6
Ventral scraper	—	—	—	—	—	—	—
Naturally backed	—	—	—	—	—	—	—
Retouched piece	35.6	20.5	5.3	13.8	5	719.1	71.4
Bisitun							
Single scraper	51.3	24.1	6.8	14.2	4.4	1253.9	71.3
Double scraper	56.4	22.6	6.3	13.3	4.3	1289.4	62.9
Convergent	52.2	20.2	5.4	16	4.9	1055.5	84.1
Transverse	42.6	29.9	7	21	5	1290	130.2
Dejeté scraper	47.5	26.6	6.4	13.4	5.4	1269.6	84.8
Denticulate	60.8	24.1	7.1	18.3	4.4	1495.5	81
Ventral scraper	—	—	—	—	—	—	—
Naturally backed	63.1	26.3	6.2	18.8	5.7	1699.8	110.5
Retouched piece	50.6	23.8	5.3	13.7	3.9	1208.6	55.6
Warwasi fine-grained							
Single scraper	49.4	25.4	7.1	14.8	5.1	1327.3	84.9
Double scraper	53.3	23.7	6.5	12.1	3.7	1356.8	47.5
Convergent	61.8	25.9	8.3	20.5	7.1	1823.1	156
Transverse	29.7	26.2	7.1	19.9	5.2	817.5	99.6
Dejeté scraper	59	22.2	8.2	15.1	5.3	1315.6	89.8
Denticulate	36.3	20.8	6.6	12.5	3.7	799.3	53
Ventral scraper	—	—	—	—	—	—	—
Naturally backed	36.5	14.8	5.3	9.4	2.9	553.6	36.5
Retouched piece	43.9	23.2	5.4	14	4.8	1057.7	73.8

Table 14. (continued)

	Length	Width	Thickness	Platform Width	Platform Thickness	Flake Area	Platform Area
Warwasi coarse-grained							
Single scraper	44.1	29.4	8.5	15.7	5.4	1300.9	92.1
Double scraper	—	—	—	—	—	—	—
Convergent	—	—	—	—	—	—	—
Transverse	36.1	28.6	6.4	28.1	4.7	1031	131.8
Dejeté scraper	—	—	—	—	—	—	—
Denticulate	49.5	27.4	8.1	17.7	6.7	1464.5	112.3
Ventral scraper	—	—	—	—	—	—	—
Naturally backed	—	—	—	—	—	—	—
Retouched piece	38.3	17.3	3.9	20.3	3.5	660.8	72.1
Kobeh							
Single scraper	43	23.3	6.9	14.5	5	1027.4	82.2
Double scraper	46.4	19.7	6.7	10.8	4.2	919.8	49.2
Convergent	45.9	18.8	7.4	11.5	4.6	869.4	61.9
Transverse	30	40.3	9.6	28.7	6.9	1269.7	239.5
Dejeté scraper	36.5	23	7.9	16.3	5.5	857	95.2
Denticulate	39.3	23.2	7.4	14.9	5.3	917.3	84.3
Ventral scraper	—	—	—	—	—	—	—
Naturally backed	39.9	16.6	6	7.3	5	661.7	38.1
Retouched piece	40	22.9	5.6	13.2	4.3	916.7	66.1
Kunji							
Single scraper	44.6	24	6.8	15.1	4.8	1082.1	76.7
Double scraper	45.3	23.8	6.6	14.2	5	1106.1	77.3
Convergent	41	19	5.5	13	4.1	799.4	52.7
Transverse	28	30.4	7	19.2	5.1	836.2	103.6
Dejeté scraper	36.6	22.9	7.3	15.2	5.5	852.9	86.6
Denticulate	41.7	27.3	7	25.1	5.9	1132.8	181.6
Ventral scraper	—	—	—	—	—	—	—
Naturally backed	48.1	17	7	7.8	3.4	817.4	26.3
Retouched piece	45.1	21	5.6	9.1	3.2	985.6	29.5
Gar Arjeneh							
Single scraper	41.2	21	6.6	14.4	5.2	866.2	80.4
Double scraper	46.8	21.8	7.2	14	5.2	1035.2	79.8
Convergent	44.8	19.8	7	14.5	4.9	894.6	83.1
Transverse	30.4	24.9	8.4	15.3	4.3	750.3	77.8
Dejeté scraper	38.5	22.9	6.8	15.2	4.8	892.7	75.1
Denticulate	34.3	21.8	7	21.2	6.1	746.2	129.9
Ventral scraper	—	—	—	—	—	—	—
Naturally backed	48.1	16.2	4.4	9	4.6	785.5	41.1
Retouched piece	36.7	17.7	4.9	13.6	4.4	668.1	64.6

Extent of cortex on tools is varied, with single and ventral scrapers and denticulates having the greatest range of percentages from none to fully cortical (Table 13). Dejeté and transverse scrapers have fewer pieces that are >50% and none that is fully cortical. The abbreviated overall size, smaller amount of cortical cover, and greater retouch intensity of transverse scrapers suggests more reduction than single scrapers, albeit possibly more so on the ends, and appears to conform to Dibble's model (1995a).

Bisitun

The sample from this site is composed of a fine-grained component selected by Coon during excavation (Coon 1951, 1957). I analyzed a sample of 245 tools, composed primarily of scrapers (Table 12).

Longitudinal flake blanks represent 87% of the tools analyzed. Of the 13% made on centripetal flakes, all are scrapers. There are no tools manufactured on cortical flakes in this sample, possibly again reflecting a selection bias by Coon. Single scrapers constitute 29% of

the tools manufactured on longitudinal blanks, while 42% of centripetal blanks are single scrapers. Double scrapers occur on 17% of longitudinal flake types and 25% of centripetal flake types. Convergent scrapers are made on 24% of longitudinal flake blanks and 17% of centripetal flake blanks.

Using the Mann-Whitney U test, I found the overall flake area (length × width) of single and double scrapers was significantly different, although double scrapers on average are longer and narrower than singles (Table 14). Individually, length, width, and thickness are all the same statistically, as well. However, these values have different means (Table 14). In addition, there is no significant statistical difference in retouch intensity of the scraper edges. Average platform area is different between these scraper types but not at a significant level.

Convergent scrapers (including Mousterian points) are smaller in flake area than double scrapers (Table 14). These differences are in length (doubles are longer) and width (doubles are wider). In addition, doubles are thicker. As thickness is not modified through retouch, it is possible that the convergent pieces were made on different-size blanks, although to conform to Dibble's model they should be thicker, not thinner. However, the overall platform area is significantly different between these types, with convergent scraper platforms being larger, suggesting (if platform size correlates with flake size) an original larger blank size for convergent types. Dibble (1987a) has explained these size differences in terms of larger blanks being retouched more before an absolute discard threshold in width is obtained. In other words, the final convergent stage cannot be reached on smaller pieces which are exhausted before this point, at single edge or double edge stages.

Interestingly, convergent scrapers have a greater retouch intensity value on one edge but have the same intensity as double scrapers on the second edge. This might suggest a problem when applying Dibble's model of reduction if both edges are not considered in the comparison. If both retouched edges are averaged, then there are no significant differences between double and convergent scrapers in retouch intensity at Bisitun (Appendix). This contradicts Dibble (1995a) again, as convergent pieces are, all things being equal, supposed to be more retouched. By using a measurable retouch index based on concrete values, as in this study, as opposed to a subjective ordinal scale based on description, a more accurate picture of retouch at Bisitun can be obtained. In any case, the data on double and convergent scrapers is inconclusive with regard to Dibble's model of reduction (Dibble 1984a).

When single scrapers are compared with convergent scrapers there are significant differences in flake size (including width and thickness) and retouch intensity (Appendix). Interestingly, length is statistically the same for both types (Table 14). There is also a significant difference in platform area, with convergent types having a larger platform, suggesting that different-size blanks may have been selected for each type (Table 14). Those artifacts discarded as single scrapers were apparently made on smaller blanks to begin with and therefore were "exhausted" before they could be reduced further (Dibble 1995a). Convergent scrapers are reduced to the same "cutoff" size as these single scrapers.

Generalized, non-specific retouched types (Bordes' types 45–50) are nearly the same size as single scrapers (Table 14). They are, however, different in thickness and in retouch intensity. Single scrapers are both thicker and have a greater retouch intensity than retouched pieces. It is possible that thicker blanks could be resharpened more intensively while thinner blanks could be utilized but then abandoned with little to no edge modification.

At Bisitun the amount of cortex remaining on each tool type is the same (Table 13). However, the overall percentage of pieces with cortex differs, with single scrapers having only 67% non-cortical pieces, double scrapers 75%, Mousterian points 91%, and convergent pieces 92% non-cortical pieces. These data suggest a rather gradual reduction in the amount of cortex as a scraper has more of the edges removed through resharpening. However, this lack of cortex could also be due to the curation and longer maintenance of larger non-cortical blanks.

Gar Arjeneh

I analyzed a sample of 143 tools from the excavation by Hole and Flannery (1967). The majority of the tools are single scrapers, followed in frequency by convergent scrapers, dejeté scrapers, double scrapers, transverse scrapers, denticulate/notched pieces, and naturally backed pieces (Table 12). There were also 19 "other" types of tools not analyzed in this study.

Only 1% of the tools is made on centripetal flakes; 8% are on cortical flakes, 82% are on longitudinal flakes, and 9% of the tools are manufactured indeterminate blanks. The lack of tools on centripetal blanks mirrors the nearly complete lack of these flakes at the site. (Note: there are five centripetal cores in this assemblage; see below.) Tools made on cortical and longitudinal flakes consist of approximately the same types, suggesting that there is little difference in selection based on cortex presence or absence.

In terms of size, the average length, width, and thickness are greater for double scrapers when compared with single scrapers but, according to the Mann-Whitney U test, not significantly (Table 14). In addition, while there is no significant difference in the retouch intensity values, the average values do become greater from the single to the double to the convergent categories. (Table 11). Double versus convergent scrapers also show a difference in mean length, width, thickness, and retouch intensity index but not significantly at the .05 level. A

Table 15. Percentages of tool types without cortex by site.

	Single Scraper	Double Scraper	Convergent† Scraper	Dejeté Scraper	Transverse Scraper	Denticulate	Ventral Scraper
Barda Balka fine-grained	48	—	—	—	56	58	48
Barda Balka coarse-grained	50	—	—	—	66	67	25
Shanidar	58	100	64	50	100	56	—
Bisitun	67	75	92	—	—	—	—
Kobeh	64	83	92	89	73	79	—
Warwasi fine-grained	65	94	88	—	100	71	—
Warwasi coarse-grained	—	—	—	—	—	—	—
Kunji	51	71	67	86	86	84	—
Gar Arjeneh	41	54	75	69	55	100	—

† includes Mousterian points

Note: Blank cells indicate insufficient sample size.

comparison of metric variables for single and convergent scrapers demonstrated differences in terms of overall flake size, including individual measurements of width and thickness, and overall platform size, but did show significant differences in length and retouch intensity (Tables 11 and 14). Convergent scrapers are longer and more heavily retouched than single scrapers.

Transverse scrapers are significantly shorter than single types. However, these scrapers have mean widths and thicknesses that are greater than that of the single types (Table 14). Double and convergent scrapers are significantly larger in overall flake area than transverse types owing primarily to their greater length. The retouch intensity index is statistically the same for all the scrapers in the assemblage, but average values increasing from singles to convergents, dejeté, and transverse scrapers follow Dibble's model (Table 11).

Dejeté scrapers are not significantly different in size from single scrapers but do have a greater retouch intensity. Double scrapers are greater in length than dejeté types but are similar in all other dimensions, including retouch intensity. Convergent scrapers are longer and less wide than dejeté scrapers but are similar in every other dimension, including overall flake size and retouch intensity. Dejeté scrapers are significantly longer than transverse types but similar in every other way. Platform size is not different for any of these tool types, except that denticulates have larger platforms and naturally backed pieces have smaller platforms. The uniform scraper platform size suggests that they may have all been made from flake blanks of similar size (Table 14).

Retouched types (Bordes' types 46–49) are statistically shorter, thinner, and smaller in overall size than single scrapers. Differences in width between single scrapers and retouched pieces show a weak statistical significance (p = .061) which might be stronger in a larger sample (Table 14). Retouch intensity is not statistically different for scrapers and retouch pieces, suggesting that single scrapers and retouched pieces are part of the same, arbitrarily subdivided retouched population.

Cortex on tools ranges from none to fully cortical for single, double, convergent, dejeté, and transverse scrapers to <25% cortex for Mousterian points and denticulates (Table 13). Again, however, the number of scrapers at each stage that are completely devoid of cortex is different, with single scrapers having the smallest percentage of non-cortical pieces followed by double scrapers, transverse types, convergent scrapers, dejeté scrapers, Mousterian points, and denticulates (Table 15). The amount of cortex remaining on scrapers appears to be inversely related to the intensity of resharpening they received during their use-lives. Only the denticulate category, assuming these are not resharpened as intensively as scrapers, is anomalous in having no cortex.

Kobeh

All 386 tools were analyzed from the Howe excavation at Kobeh. Single scrapers constituted the largest percentage of the tool total, followed by convergent scrapers (including Mousterian points), double scrapers, retouched pieces, denticulates, dejeté scrapers, transverse scrapers, and naturally backed pieces (Table 12). Tools are overwhelmingly made on longitudinal flakes (87%); 1% are made on centripetal flakes, 1% on cortical flakes, and 11% on other, or indeterminate, flake types.

The scraper percentage for longitudinal blanks is nearly identical to that for all blanks as the assemblage is dominated by this flake type. Cortical flakes are made into single, double, and transverse scrapers. Centripetal flakes are made into single and convergent scrapers.

Single scrapers are not significantly larger overall than double scrapers ($p = .06$). However, double scrapers are, on the average, longer and narrower than single scrapers. Thickness does not differ among these scraper types (Table 14). A larger sample size might help to clarify these relationships. Retouch intensity is statistically the same for both types, but single scrapers have a smaller average value (Table 11).

Double scrapers are not significantly different in any dimension (including platform area) from convergent scrapers but convergent types are on average shorter, narrower, and thicker than double scrapers (Table 14). Double scrapers have larger mean values for retouch intensity than single types, but the difference is not significant (Table 11).

When single and convergent scrapers are compared, significant differences in overall flake area, length, width, and retouch intensity are demonstrated but there are no differences in platform size or thickness (Table 14).

Dejeté scrapers differ from single scrapers in terms of length, platform width, and retouch intensity (Tables 11 and 14). That single scrapers tend to be longer than dejeté scrapers is, of course, expected. That platform width is greater in dejeté scrapers or that these types are more heavily retouched than single scrapers is also to be expected. Double scrapers are also longer on average than dejeté types but tend to be narrower and to have smaller platforms. Retouch intensity is not statistically different for these types, although dejeté scrapers have larger average values (Table 11). Convergent types show the same pattern as doubles, tending to be longer and narrower and to have significantly smaller platforms than dejeté types (Table 14). These platform differences suggest either (1) that the reduction of double and convergent types is reducing the overall platform area by truncating the platform edge (specifically the platform width) or (2) that blanks selected for double and convergent types were originally smaller than those used to make dejeté scrapers. In addition, since in general single types have even larger platform areas at Kobeh, we cannot determine where dejeté scrapers would have "fit" in the same reduction sequence.

Transverse scrapers are significantly smaller in length, thickness, and platform dimensions than are single, double, and convergent scrapers but, of course, are significantly wider (Table 14). This translates into an overall flake area that is slightly larger and a retouch intensity value that is larger than for all but dejeté scrapers. Transverse scrapers are shorter, wider, thicker, and have larger platforms than dejeté scrapers. The difference in dimensions between transverse and other scraper types (especially in thickness and platform area) precludes their consideration as part of any overall linear reduction process at Kobeh.

Denticulates and notched pieces at Kobeh are similar to single and dejeté scrapers in every respect. Double, convergent, and transverse scrapers are all different than denticulates/notched pieces in terms of length, width, and platform area statistics. Denticulates tend to be shorter, wider, and to have larger platforms than double and convergent types. Denticulates are longer, narrower, and have smaller platforms than transverse types (see Table 14).

Retouched Bordian types 45–50 are not statistically different from single scrapers in terms of overall flake size and platform area but differ significantly in thickness and retouch intensity (Table 14). These flake types average smaller values than single scrapers for every measurement (Table 14).

Less than 4% of the tools at Kobeh have >50% of the dorsal surfaces covered in cortex; half of these are single scrapers (Table 13). As has been shown for several of the other sites, there is also a gradual increase in the percentage of tools that are non-cortical at Kobeh (Table 15).

Kunji

A sample of 158 tools was studied from the excavation at Kunji by Hole and Flannery (1967). The tool sample is dominated by single scrapers, followed by double scrapers, dejeté types, convergent scrapers, transverse types, naturally backed pieces, and denticulates (Table 12).

The types of flake used to manufacture these tools are as follows: 81% are longitudinal blanks, 6% are cortical flakes, 2% are centripetal flakes, and 11% are other or indeterminate pieces. As at the other sites in this study, longitudinal flakes dominate the assemblage.

Single scrapers are not statistically different than double scrapers in total flake area, length, width, thickness, retouch intensity, and platform area (Appendix). However, these types are, on average, larger in every category except retouch intensity (Tables 11 and 14). Double scrapers are not significantly different than convergent pieces in flake area, length, thickness, retouch intensity, and platform area. However, the width of these two types is significantly different (at the .05 level), with double scrapers being wider than convergent types (Appendix). Double scrapers average smaller values in every category except length (Table 14). Comparing single with convergent scrapers shows no significant difference in flake area, length, thickness, platform area, or retouch intensity even though all these mean values are larger for single types (Table 14). Width is significantly different as was seen in the double versus convergent comparison (Table 14).

The small sample of dejeté scrapers is shorter on average than single scrapers and nearly the same width, causing overall flake area to be significantly less as well (Table 14). Double scrapers are not quite significantly longer than dejeté scrapers ($p = .068$) but are different in every other dimension. Dejeté scrapers are significantly wider than convergent types but statistically similar in

every other dimension, despite the greater average values for dejeté scrapers in width and thickness, and the greater mean values in length, platform width, and platform thickness (Table 14).

Denticulates and notched pieces have larger platform widths than single, double, convergent, and dejeté scrapers. However, there are no other significant size differences between these tool types, including overall platform size (Table 14). As expected, transverse scrapers are different only in length. This suggests similar blanks were used for all these tool types.

Miscellaneous retouched tools, Bordes' types 46–49, could not be analyzed statistically owing to the small sample size. However, there are differences in platform width, platform thickness, retouch intensity, and overall platform size between these tool types and single scrapers.

Less than 8% of the tools at Kunji are >50% cortical, and the vast majority of these are single scrapers (75%). In fact, single scrapers are the most frequent tool type to be non-cortical, followed in diminishing order of cortex by convergent scrapers, double scrapers, denticulates, transverse types, and dejeté scrapers (Table 13).

Shanidar

From Shanidar, 54 tools were analyzed: in descending order of frequency, convergent scrapers (and Mousterian points), single scrapers, denticulates, double scrapers, miscellaneous retouched pieces, dejeté, transverse, and naturally backed pieces (Table 12).

Longitudinal flakes are made into 84% of the tools, centripetal flakes are made into 2%, and 14% of the tools were manufactured on other or indeterminate pieces.

Single scrapers did not differ statistically from double scrapers in flake area, length, thickness, platform area, and retouch intensity (Tables 11 and 14), although sample size is very small and mean data show singles larger in every category. The difference in tool width is significant, however (Appendix).

Double and convergent scrapers are more similar in size although convergents are thicker and the platforms are larger (Table 14).

Single and convergent scrapers are different in overall flake area and width but not significantly different in length, thickness, platform area, and retouch intensity (Table 14). The mean length of single scrapers is larger in this sample.

Transverse and dejeté scrapers make up <5% of the tools in this sample and were not used in the analysis.

Denticulates represent 14% of the tools in this sample. Akazawa's (1975:5) analysis of layer D material in the Iraq Museum shows 88 denticulates and notched pieces out of 714 implements, or 12%. There are no significant size differences (including platform area) between this tool type and single, double, or convergent scrapers, although denticulates are, on the average, shorter than single, double, and convergent scrapers and wider than all but single scrapers.

Retouched pieces (Bordes' types 46–49) are significantly shorter than single scrapers in length, and this affects the overall flake area. Single scrapers also have a greater mean thickness than retouched pieces. All other dimensions are not statistically different (Table 14).

No tools in the Shanidar sample are >75% cortical (Table 13). In fact, only 6% of the tools have >25% cortex on the dorsal surface and only 33% have any cortex at all. Single scrapers have more non-cortical flakes than either denticulates or dejeté scrapers (Table 15). Convergent scrapers have more non-cortical flakes than singles, followed by Mousterian points, and double and transverse scrapers each have 100% non-cortical pieces. These anomalous results could be due to the small sample size analyzed.

Warwasi—Fine-Grained Material

A sample of 129 tools excavated from Warwasi by Howe was analyzed to enable comparison with results of a previous analysis (Dibble and Holdaway 1993) and with the other sites in this study.

More than one-third of the tools analyzed from Warwasi were single scrapers, followed in descending order by denticulates, miscellaneous retouched pieces, double scrapers, convergent scrapers, naturally backed, dejeté scrapers, and transverse scrapers (Table 12).

Eighty-three percent of the tools are made on longitudinal flakes, 5% on centripetal flakes, <1% on cortical flakes, and 11% on other/indeterminate flake types.

In the longitudinal flake type, 24% are single scrapers, 9% are double scrapers, 6% are convergent scrapers, 16% are denticulates, 6% are naturally backed, and <1% are dejeté or transverse.

Single scrapers are not significantly different than double scrapers in terms of flake size, length, width, thickness, or retouch intensity (Appendix). However, single scrapers have a shorter mean length (Table 14). They are significantly different, however, in platform area, with single scrapers having larger platforms.

Double scrapers do not differ from convergent scrapers in overall flake size, length, width, thickness, or overall retouch intensity (both edges considered). Again, however, double scrapers are, on the average, shorter than convergent types (Table 14). As with the single versus double scraper comparison, there is a significant difference in platform area between double and convergent types, with the latter types being larger by a large margin (Table 14).

When single and convergent types are compared, the same pattern is found; no significant size differences exist except in the larger platform areas of the convergent types, but single types on average are shorter and narrower (Table 14).

Transverse and dejeté scrapers consititute only 4% of the tools in this sample and were not included in the statistical analysis.

Denticulates at Warwasi are significantly smaller than single scrapers in length, width, platform thickness, flake area, and platform area. Denticulates are also smaller than double types in length and flake area and are smaller than convergent types in length, platform width, platform thickness, platform area, and flake area (Table 14).

Naturally backed pieces (Bordes' type 38) are significantly different from single scrapers and convergent scrapers in all size categories, being smaller in every instance. Double scrapers are different in length, width, and overall flake area. Naturally backed pieces are significantly different from denticulates in width and overall flake area (Table 14), but have mean values that are smaller in all categories.

Bordes' miscellaneous retouched types 46–49 are significantly smaller in thickness and in retouch intensity than single scrapers, continuing a pattern seen at most of these sites (Tables 11 and 14).

Cortex percentages at Warwasi show single scrapers having the most non-cortical tools followed by denticulates, convergent scrapers, double scrapers, and transverse scrapers (Table 15). Single scrapers have the greatest range of cortex percentages followed by denticulate pieces. This is interesting as denticulates are smaller overall than the scrapers and yet tend to have as much or more cortex than those other tools. This suggests that the blanks selected for denticulates may have been different from those used for scrapers.

The sample of coarse-grained tools from Warwasi was too small for any statistical analysis to be meaningful.

Summary for Tools

The tool components at these sites are, like the flake components, dominated by uni- and bidirectional longitudinal flakes. Centripetal flakes are rare, never exceeding 15% of the total flakes recovered.

It is clear that at all the sites studied except Shanidar, single scrapers are longer than double scrapers (Table 14 and Appendix). Platform area of these scrapers is also larger at all sites except Barda Balka (fine-grained subassemblage) and Kunji. However, at Barda Balka there were very few double and convergent pieces and so these results are preliminary.

In addition, the retouch intensity for single versus double scrapers is lower at every site but Barda Balka, but again the small sample of double scrapers precludes taking this any farther (Table 11).

The mean length of double scrapers is shorter than convergent types only at Warwasi (fine-grained), yet platform area averages are greater only at Kunji.

The retouch intensity index is not significantly different for these two scraper types (at Barda Balka these scrapers are not compared because of the paucity of double scrapers) (Table 11). However, double scrapers average larger values at Kunji, Gar Arjeneh, Kobeh, and Shanidar.

Transverse scrapers have smaller average flake areas than single scrapers at all sites except Kobeh and Bisitun. Platform area is larger at all sites except Barda Balka (fine-grained) and Gar Arjeneh. In addition, transverse scrapers have less cortex remaining at Barda Balka (both fine- and coarse-grained), Gar Arjeneh, Kobeh, and Kunji. Retouch intensity of transverse types is greater at every site except Warwasi-fine. However, Bisitun, Shanidar and Warwasi have too few transverse types to derive much from this comparison.

Dejeté scrapers have approximately the same overall flake area as single scrapers but have larger platform areas, especially platform thickness, at all sites except Gar Arjeneh and Shanidar (where the sample size is small).

The tool category results indicate that there was a reduction in length from single to double to convergent scrapers at Shanidar (Table 14). Double scrapers are longer than singles at Bisitun, Warwasi (fine-grained), Kobeh, Kunji, and Gar Arjeneh. Convergent scrapers are longer than double scrapers only at Warwasi (fine-grained) and larger than single types at Warwasi (fine-grained), Bisitun, Kobeh, and Gar Arjeneh. Platform data from these sites suggest convergent scrapers began with a larger blank at Warwasi (fine-grained) and Bisitun, probably as single scrapers. Platform data are more or less the same for single, double, and convergent types at Shanidar, Kobeh, Kunji, and Gar Arjeneh. These results suggest that the same size population of flakes was being selected for the single/double/convergent reduction sequence at every site except Warwasi and Bisitun, where smaller flakes were being utilized and discarded as single and double scrapers possibly owing to raw material stress.

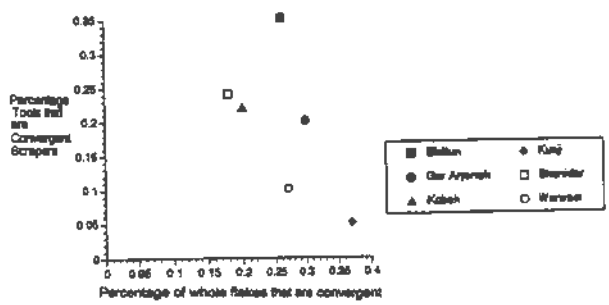


Figure 26. Comparison of convergent tools and flakes.

However, there is evidence that convergent scrapers may have been made specifically on convergent-edged flakes from the start. Figure 26 shows the relationship of the percentage of tools that are convergent scrapers to the

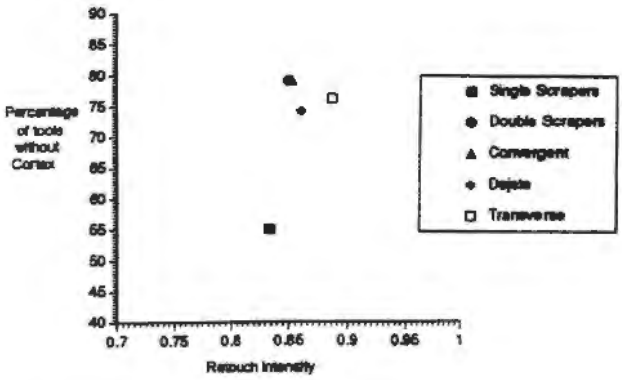


Figure 27. Non-cortical tools and retouch intensity.

percentage of whole flake blanks with a convergent shape. There is a negative correlation between these convergent-edged pieces. In other words, selecting more convergent blanks to make into convergent scrapers leaves fewer of these blanks to be discarded unretouched. This suggests that the shape of the blank used affects the tool shape made from it. This conclusion still does not answer the question of whether or not these tools were made to be pointed, either as projectiles or for other functions. The frequencies of convergent blanks remaining at these sites are very similar to those of the other three main shapes produced (round, parallel, and divergent). Given the high numbers of convergent scrapers, it is possible that convergent blanks were made in greater numbers and consequently selected more frequently than any other blank shape. A longitudinal flaking of an oblong pebble of radiolite will produce convergent-edged pieces without changing from a uni- or bidirectional technique. Why convergent flakes would have been specifically selected is not known at this time.

Retouch intensity for single, double, and convergent types is statistically the same. However, the mean values show a definite trend to greater intensity of retouch from either single to double to convergent or single to transverse trajectories (Table 11). In fact, 29 of 35 mean retouch values for the Zagros Mousterian sites analyzed, or 83%, follow Dibble's reduction model. Of those cases that do not conform to the model, all but Kunji convergent and transverse scraper categories can be attributed to small sample size, leading to an adjusted figure of 94% for cases that match.

In addition, when the percentage of non-cortical pieces is examined for each scraper class as a measure of the amount of reduction that occurred, there is a clear trend of less cortex remaining from single to double to convergent at every site but Shanidar, Warwasi (fine-grained), and Kunji (Table 15). There is also less cortex remaining from single to transverse types at every site. Dejeté scrapers have less cortex than single scrapers at Kobeh and Kunji and more at Shanidar and Gar Arjeneh.

When the average percentage of non-cortical flakes in each scraper category is plotted against the average retouch intensity values for the entire region it is clear that single scrapers have more cortical cover and less resharpening than the other scraper types (Figure 27). Double and convergent scrapers are nearly the same in terms of cortex remaining and retouch intensity. Dejeté scrapers have less non-cortical pieces and less retouch intensity than transverse scrapers.

In terms of tool type frequencies, Gar Arjeneh and Kunji have the highest percentages of both single and dejeté scrapers. Bisitun and Kobeh have the highest percentages of double scrapers and, along with Shanidar, the highest percentages of convergent scrapers. Barda Balka (fine- and coarse-grained components) have the highest percentages of transverse scrapers and denticulates. Warwasi (coarse-grained) and Barda Balka (coarse-grained) have the highest percentages of naturally backed pieces. From this it is clear that Bisitun, Shanidar, and Kobeh have the greatest frequency of more intensively retouched types and therefore would have had the greatest stress on raw material.

Table 16. Spearman Rank Order correlations for selected tool types.

	Single Scraper	Double Scraper	Convergent Scraper	Dejeté Scraper	Transverse Scraper	Denticulate	Naturally Backed	Misc. Retouched
Single scraper	1							
Double scraper	0.854	1						
Convergent	0.686	0.87	1					
Dejeté scraper	0.898	0.851	0.834	1				
Transverse	0.539	0.266	0.219	0.538	1			
Denticulate	–0.067	–0.226	–0.276	–0.254	0.387	1		
Naturally backed	0.126	–0.118	–0.277	–0.162	0.418	0.653	1	
Misc. retouched	0.05	0.388	0.3	0.026	–0.254	0.067	–0.143	1

Table 17. Core type frequencies by site.

	Centripetal	Longitudinal	Truncated/Faceted	Amorphous	Fragment
Barda Balka fine-grained	52	109	8	18	319
Barda Balka coarse-grained	17	31	0	2	n/a
Bisitun	54	44	9	4	38
Gar Arjeneh	6	17	7	5	—
Kobeh	17	67	42	22	146
Kunji	1	9	4	1	n/a
Shanidar	0	1	0	0	n/a
Warwasi (all)	34	95	99	13	107

Table 18. Core size (length × width × thickness) by type and site (in mm^3).

	Centripetal	Longitudinal	Truncated/Faceted	Amorphous
Barda Balka fine-grained	21,784.40	22,067.21	13,664.09	14,205.46
Barda Balka coarse-grained	163,731.47	84,475.07	n/a	144,382.55
Shanidar	n/a	n/a	n/a	n/a
Gar Arjeneh	23,797.13	17,834.50	14,731.75	17,442.84
Kunji	25,580.33	15,412.52	8,610.97	16,483.37
Kobeh	11,562.61	14,613,09	9,462.67	31,284.55
Bisitun	19,305.46	24,307.77	11,782.69	11,523.12
Warwasi fine-grained	26,789.10	42,531.02	8,239.77	133,706.68

When a Spearman Rank Order correlation is calculated for the frequency of tool types at these Zagros sites, it is clear that single, double, convergent, and dejeté types are strongly correlated (Table 16), suggesting a linear resharpening sequence like that proposed by Dibble. The frequency of transverse types, however, does not correlate with any other tool types. This result suggests that transverse scrapers were not part of a single-to-transverse-scraper sequence but were a separate, single-step resharpening of specific flakes of a different shape than those made into other scrapers (Kuhn 1992b). The frequencies of denticulates and naturally backed pieces are correlated with each other but not with any of the other tool types. The frequency of miscellaneous retouch pieces is not correlated with any other tool types.

Cores

The major attributes examined on each core were: (1) the type of core (longitudinal, centripetal, truncated/faceted, etc.) (Table 17); (2) the overall size of the core (Table 18); (3) the size of the last removals from the core (Table 19); and (4) the amount of cortex present (Table 20).

Barda Balka

Fine-Grained Material

From the fine-grained sample, 187 cores were analyzed. The majority are longitudinal cores followed by centripetal cores, amorphous cores, and truncated/faceted types (Table 17).

Cortex is present on a majority of the cores no matter what the reduction strategy, more than likely because of the use of radiolarite pebbles for raw material (Table 20). At least some cortex is present on 67% of the longitudinal cores. Centripetal cores have 58% with cortex; amorphous cores have 56%, while truncated/faceted pieces have only 13%. The lack of cortex on truncated/faceted cores has to do with their origin as flakes rather than as original raw material.

There are no significant size differences between any of the fine-grained cores from Barda Balka except centripetal and amorphous types. However, it is clear the mean sizes for these cores can be divided into two groups: a larger group of longitudinal and centripetal cores and a smaller group consisting of amorphous and truncated faceted cores.

The size of the final removals for each core type varies quite a bit (Tables 19 and 21). However, the majority of cores are either longitudinal or centripetal types and these are not significantly different from each other (Table 21). The amorphous cores have significantly smaller last flake removals than either longitudinal or centripetal cores. The final flakes removed from truncated/faceted cores also appear to be different in size than those taken from longitudinal ($p = .057$) or centripetal ($p = .058$) types, but the sample size is small. A larger sample might clarify this relationship.

Table 19. Size (length × width) of the last removal by core type and site.

	Centripetal	Longitudinal	Truncated/Faceted	Amorphous
Barda Balka fine-grained	407.59	411.13	283.14	260.46
Barda Balka coarse-grained	963.36	790.26	n/a	1179.24
Shanidar	n/a	n/a	n/a	n/a
Gar Arjeneh	506.22	292.11	385.93	354.55
Kunji	357.68	318.80	223.63	243.55
Kobeh	305.50	326.20	300.58	539.12
Bisitun	392.43	329.81	283.01	211.40
Warwasi (all)	414.04	526.94	235.29	406.91

Table 20. Percentage of cores without cortex by core type and site.

	Centripetal	Longitudinal	Truncated/Faceted	Amorphous
Barda Balka fine-grained	42.31	33.03	87.5	44.44
Barda Balka coarse-grained	41.18	19.35	n/a	24
Shanidar	n/a	n/a	n/a	n/a
Gar Arjeneh	33.33	0	28.57	20
Kunji	0	11.11	100	0
Kobeh	82.35	56.72	78.57	54.55
Bisitun	38.89	18.18	66.67	40
Warwasi fine-grained	26.47	23.16	78.79	15.38

Coarse-Grained Material

From the coarse-grained component at Barda Balka, 50 cores were analyzed. Again longitudinal cores are most frequent, followed by centripetal types and amorphous cores (Table 17). No coarse-grained truncated/faceted cores were recovered from this site. The percentages of these various core types are very similar to those in the fine-grained component.

Cortex is present on 37 of the cores or 74% of the total. Only 19% of the longitudinal cores are non-cortical whereas 41% of the centripetal cores have no cortex. The two amorphous cores have <25% of the surface covered with cortex (Table 20).

As is the case with the fine-grained cores at this site, the average sizes of longitudinal and centripetal cores are statistically the same (Table 21). Amorphous cores also show no significant difference in overall size from the rest of the sample. However, the mean size differences show centripetal and amorphous cores to be very close, with longitudinal cores being smaller on average (Table 18).

The sizes of the final removals from all three core types are not significantly different from one another (Tables 19 and 21). However, facets from amorphous cores are larger on average than those on the other cores in the sample. The lack of truncated/faceted cores in the coarse-grained component is interesting and inexplicable at this time. If truncated/faceted cores are an expedient means to produce flakes (Goren-Inbar 1988:43), there does not appear to have been a need to do this with the coarse-grained material.

Bisitun

Bisitun is unique among the sites because the majority of the 111 analyzed cores are centripetal, followed by longitudinal, truncated/faceted, and finally amorphous types. Again, the selective nature of the sample could be artificially inflating the number of centripetal types

The majority of centripetal, longitudinal, and amorphous types still have some cortex present (Table 20). Centripetal and amorphous cores have less cortex than do the longitudinal cores in the sample. Truncated/faceted core types have 67% without cortex, again reflecting the origin of these cores as flakes.

Overall core size is not significantly different for longitudinal and centripetal types (Tables 18 and 21). Amorphous cores are significantly smaller than longitudinal types ($p = .021$) but not quite significantly different from centripetal cores ($p = .068$). However, the mean size of amorphous cores is considerably smaller, and the small sample of amorphous types could be affecting the results. Truncated/faceted cores are significantly smaller in overall size than both centripetal and longitudinal cores but are similar to amorphous types.

Table 21. Mann-Whitney U test probability values for core types by site.

	Sample Size			
	N_1	N_2	Core Size	Last Flake
Barda Balka fine-grained				
Centripetal/Longitudinal	52	109	0.285	0.917
Centripetal/Amorphous	52	18	0.028	0.0001
Centripetal/Truncated-Faceted	52	8	0.287	0.058
Longitudinal/Amorphous	109	18	0.128	0.0001
Longitudinal/Truncated-Faceted	109	8	0.489	0.057
Barda Balka coarse-grained				
Centripetal/Longitudinal	17	31	0.108	0.643
Centripetal/Amorphous	17	2	0.79	0.506
Centripetal/Truncated-Faceted	—	—	—	—
Longitudinal/Amorphous	31	2	0.227	0.571
Longitudinal/Truncated-Faceted	—	—	—	—
Bisitun				
Centripetal/Longitudinal	54	44	0.411	0.052
Centripetal/Amorphous	—	—	—	—
Centripetal/Truncated-Faceted	54	9	0.017	0.271
Longitudinal/Amorphous	—	—	—	—
Longitudinal/Truncated-Faceted	44	9	0.006	0.943
Gar Arjeneh				
Centripetal/Longitudinal	6	17	0.263	0.122
Centripetal/Amorphous	—	—	—	—
Centripetal/Truncated-Faceted	—	—	—	—
Longitudinal/Amorphous	—	—	—	—
Longitudinal/Truncated-Faceted	17	7	0.172	0.215
Kobeh				
Centripetal/Longitudinal	17	67	0.933	0.277
Centripetal/Amorphous	17	22	0.004	0.228
Centripetal/Truncated-Faceted	17	42	0.06	0.762
Longitudinal/Amorphous	67	22	0.004	0.01
Longitudinal/Truncated-Faceted	67	42	0.008	0.206
Kunji	—	—	—	—
Shanidar	—	—	—	—
Warwasi fine-grained				
Centripetal/Longitudinal	34	95	0.14	0.103
Centripetal/Amorphous	34	13	0.039	0.006
Centripetal/Truncated-Faceted	34	99	0.0001	0.004
Longitudinal/Amorphous	95	13	0.333	0.0001
Longitudinal/Truncated-Faceted	95	99	0.0001	0.0001

Note: Blank cells indicate insufficient sample size for test.

The sizes of the last flakes removed from longitudinal and centripetal cores are significantly different (<.05 level) from one another, with the final centripetal flakes being larger (Tables 19 and 21). Amorphous cores have smaller final flake removals than both centripetal and longitudinal cores. The last flakes off truncated/faceted types are not significantly different from those off longitudinal or centripetal types. However, truncated/faceted cores average smaller flakes than either centripetal or longitudinal types but larger flakes than amorphous types. This is compelling evidence that truncated/faceted types did produce flakes comparable in size to those from other cores present at the site and, therefore, could be considered as proper cores.

In comparison, Dibble (1984a) lists 108 cores in his analysis of Bisitun. This total did not, however, include 115 truncated/faceted pieces. The 56 cores measured by Dibble averaged 39.55 mm in length, 31.87 mm in width, and 14.28 in thickness, a slightly smaller average size

than the longitudinal and centripetal cores analyzed in my study, but no additional data are presented on the core sample that can be used in my analysis.

Gar Arjeneh

The 35 complete cores available for analysis from the Hole and Flannery (1967) sample are primarily longitudinal types, followed by truncated/faceted, centripetal, and amorphous cores (Table 17).

Cortex is present to some extent on 86% of the cores, with the amounts on each core type appearing fairly uniform (Table 20).

There are no significant differences in overall core size or final flake removal for the core sample (Tables 18, 19, and 21). However, centripetal cores have the largest mean size and produced the largest final flakes. Truncated/faceted cores had the smallest mean size but produced the second largest final flakes.

The technology at Gar Arjeneh yielded cores that were discarded after producing a "normal" size final flake at a size very similar to those found in the rest of the region.

Kobeh

I analyzed a sample of 148 complete cores from Kobeh. They consist of a majority of longitudinal cores, followed by truncated/faceted cores, amorphous cores, and centripetal cores (Table 17).

The percentage of cortex on these cores is different from those at the preceding sites in that there are more non-cortical cores at Kobeh: 65% of the total cores analyzed have no cortex (Table 20). Centripetal cores have the least cortex, followed by truncated/faceted types, longitudinal types, and amorphous types. The reasons for this lack of cortex could include raw material differences, method of initial testing, preparation, different position in the same reduction trajectory, or greater reduction. The high percentage of truncated/faceted cores could indicate more stress on raw material and greater reduction. Kobeh has some of the smallest longitudinal and centripetal cores in the region, and these cores produced the smallest final flakes in both categories.

Overall core size is not significantly different for longitudinal and centripetal cores (Tables 18 and 21). In contrast to most of the other Zagros Mousterian sites, Kobeh has amorphous cores that are significantly larger than its centripetal or longitudinal types. Truncated/faceted cores at Kobeh are smaller than both centripetal and longitudinal types.

The final flake removed from longitudinal and centripetal cores is nearly the same size in both categories (Table 19). Longitudinal cores produced a smaller flake on average than amorphous cores, whereas there is no significant difference in the size of final flakes between centripetal and amorphous cores. Truncated/faceted cores produced final flakes that are not significantly different than those from either longitudinal or centripetal cores, again demonstrating that usable flakes of the same size were being removed from these pieces as well as from the more recognized core types.

Kunji

Only 15 cores were recovered from the excavation by Hole and Flannery (1967) at Kunji. Nine are longitudinal types, four are truncated/faceted cores, and there are two amorphous types and one centripetal core (Table 17).

All of the truncated/faceted cores are non-cortical. Only one of the longitudinal cores is non-cortical, and the remainder of longitudinal types and the centripetal and amorphous cores have some cortex (Table 20). In fact, 37% of the cores from Kunji have more than 50% cortex remaining.

In all statistical analyses the very small sample sizes must be kept in mind. The single centripetal core is larger than any other core at the site. Platform cores and the single amorphous core are very similar in overall size. Truncated/faceted cores have a smaller average size than the rest (Table 18). The final flake removals from centripetal and longitudinal flakes are larger than those from truncated/faceted and amorphous cores.

Baumler and Speth (1993) analyzed 24 complete cores from Speth's (1971) excavation at Kunji. These are described as "characteristically thin, small, circular or subcircular, 'flattened' disc cores" (1971:8). These cores have radial or subradial flaking on them and would be classified as centripetal in this study. There is no mention of longitudinal types. Their sample is different from the 15 cores discussed here, of which only one is classified as a "disc core." The cores analyzed by Baumler and Speth averaged 4.4 cm in length and 3.8 cm in width. The paucity of cores recovered from these two excavations suggests the transport of cores to another location (see discussion below).

Shanidar

Only one core is available for study from the Shanidar collection housed at Texas A & M University.

Akazawa (1975:4) counted 130 core and core fragments in the layer D material curated in Iraq. The cores are described as "variable in form" but no further information is presented. Solecki (1971:264) notes there were only "four or five diminutive Levallois cores" and the rest were a "residual" type (probably including longitudinal, centripetal, and amorphous types).

Warwasi

Of the 241 fine-grained cores analyzed from the Mousterian levels at Warwasi, the majority are truncated/faceted cores, followed by longitudinal types, centripetal types, and amorphous cores (Table 17). Warwasi is the only site where truncated/faceted cores dominate the assemblage.

Nearly half of the cores are non-cortical, in large part reflecting the large number of truncated/faceted pieces without cortex (Table 20). Centripetal, longitudinal, and amorphous categories (in that order) have fewer pieces without cortex.

Longitudinal and centripetal cores are not significantly different in size (Tables 18 and 21), but longitudinal types show a much larger average size. However, amorphous types are larger than any other category of core at the site. Truncated/faceted pieces are much smaller than longitudinal, centripetal, and amorphous cores.

The final flake removals from centripetal and longitudinal cores are statistically similar in overall size (Table 21). Amorphous cores produced final removals similar in size to those from platform cores but smaller than removals from centripetal types. Truncated/faceted types produced a significantly smaller final flake than any of the other core types.

The difference in final flake scar size between truncated/faceted and the more recognized core types at this site is similar to that seen at Barda Balka but unlike at any of the other Zagros sites examined in this study and could be due to the overall large size of the recovered cores.

Dibble and Holdaway (1993) do not describe the cores from this site except to note the presence of 96 truncated/faceted pieces. These are not treated by them as cores, per se, but are compared with retouched and non-retouched flakes and tools.

Summary of Cores

The core frequencies at each site reflect different patterns than those seen in the flakes or tools. While longitudinal flakes still dominate at every site except Warwasi, centripetal cores make up a much greater percentage of total cores than is expected based on the frequency of centripetal flakes or tools present in these assemblages. These cores make up 9–48% of the total cores found at these sites (Table 17). The lack of correspondence between the centripetal core and flake frequencies could be related to the differences in size between the last removals from the cores and the sizes of the flakes analyzed. The final removals from centripetal cores average 4.49 cm^2 (length by width), whereas the flake size for centripetal blanks averages 9.17 cm^2 and for tools, 11.06 cm^2. With many of the final removals from these cores being at or below the arbitrary 2 cm cutoff used in this analysis, it is no wonder the centripetal flake count is so low.

Truncated/faceted cores make up 0–41% of the cores in these assemblages. Unfortunately, for the purpose of my analysis it was necessary to ignore the potential products of these cores by only examining flakes and tools >2 cm in minimum dimension, mainly because this flake size is unavailable for study at Bisitun or Warwasi, having been disposed of in the field.

The amount of cortex remaining on the cores appears to support the longitudinal-to-centripetal-core trajectory noted by Baumler (1988). The percentage of centripetal cores without cortex is higher than for the longitudinal sample at every site (Table 20). Truncated/faceted cores have the least amount of cortex at all sites except Gar Arjeneh. Amorphous cores have the lowest percentages of cortex at Warwasi and Gar Arjeneh, and the highest percentage of cortex (not including truncated/faceted cores) at Barda Balka-fine and Bisitun.

Centripetal cores are smaller than longitudinal cores except at Kunji, Gar Arjeneh, and Barda Balka (coarse-grained component). These three assemblages have the smallest core samples as well. Sample size could be affecting the results.

At sites where truncated/faceted frequencies are high—Gar Arjeneh, Kobeh, Kunji, and Warwasi—centripetal core frequencies are low. In addition, where truncated faceted cores are not as frequent—Barda Balka fine- and coarse-grained components, and Bisitun—centripetal core frequencies are higher. However, both centripetal core frequency ($R = .941$) and truncated/faceted core frequency ($R = .917$) are correlated with frequency of longitudinal cores in the Zagros Mousterian (Spearman Rank Order correlations are 0.757 and 0.679, respectively). Yet, centripetal and truncated/faceted cores are not related to, or correlated with, each other. The most parsimonious explanation for these relationships is that both centripetal and truncated/faceted cores are made from either the longitudinal cores themselves or from the flakes produced from these cores. As frequency of longitudinal cores increases, so do these "by-products." However, the frequencies of these cores are not correlated with one another, suggesting other processes are affecting the frequencies of each core type (see below).

The average size of the final flakes removed from centripetal cores is smaller than for those flaked from longitudinal cores at Barda Balka-fine, Kobeh, and Warwasi (Table 19). The average size of the flakes removed from truncated/faceted cores is smaller than those from centripetal and longitudinal cores at every site but Gar Arjeneh.

Discussion

The results of the lithic analyses present a picture of a regional industry that prolonged the use life of the available raw material. The Zagros Mousterian core technology is interesting because of the contrast between truncated/faceted cores and centripetal cores.

The percentage of truncated/faceted cores at each site is negatively correlated with average flake size (rank order = –.643). This indicates that as larger flakes were used up or removed from the site, by being made into tools, only smaller flakes were left, and these were unsuitable as truncated/faceted cores and were discarded.

Another way of looking at this result is that the percentage of truncated/faceted cores at these sizes is positively correlated with the total flake count (R = 0.90). The more flakes that are available as raw material, the more truncated/faceted cores can be manufactured.

Truncated/faceted cores are also positively correlated with average tool size (Rho = 0.800). The intensive reduction of tools in these assemblages "used up" the raw material blanks available for use as cores. This can also be seen in a comparison of truncated/faceted cores and retouch intensity values, where as the intensity of resharpening increases, frequency of truncated/faceted cores decreases (R = 0.94). In heavily reduced/resharpened assemblages there is less raw material in the form of flakes that can be used as cores.

In contrast, centripetal cores are positively correlated with retouch intensity values (R = 0.93). As an assemblage is repeatedly resharpened and used up, there is stress on the technology to produce more usable flakes. If flakes are not available for use as cores, then another core reduction strategy must be employed. Since centripetal cores appear to be produced late in the regional reduction trajectory, these cores are an attempt to obtain every last bit of usable stone from the available raw material. It is interesting that all 24 cores reported by Baumler and Speth (1993) for Kunji are "disc" (centripetal) cores, the final stage of core reduction. In addition, the percentage of centripetal cores at each site is correlated with the average size of the primary or cortical flakes (Rho = 0.953). It may be that centripetal cores could only be produced at the end of the reduction sequence if the raw material was originally of a certain size, and this larger raw material would produce equally large cortical flakes. Centripetal and truncated/faceted cores can be seen as two sides of the same coin. Both are indicative of a heavily reduced assemblage and both are strategies to extend the raw material available in the Zagros Mousterian. The different frequencies of these two core types, however, are related to the location of the sites in which they occur.

Sites at higher elevations have smaller percentages of centripetal cores (Rho = –0.917); in other words, as elevation increases, the frequency of centripetal cores in an assemblage relative to all other core types decreases. In contrast, these higher sites have greater percentages of truncated/faceted cores (Rho = 0.742). There is also a decrease in average cortical flake size as elevation increases (Rho = –0.883), and a decrease in retouch intensity values as well (Rho = –0.618).

In the Zagros Mousterian, centripetal cores were being used at lower altitudes and truncated/faceted cores were used at higher elevations to extend the utility of the local raw material. The reasons for this are no doubt complex. However, truncated/faceted cores (made on large flakes) would be easier to carry around and also easier to make, if flake raw material were available. The processing of pebble raw material, taking place at lower elevations, was producing larger cortical flakes. Perhaps the sizes of raw material varied at different elevations, although this has never been noted in the literature. In addition, tools were not being used and resharpened as heavily at higher elevations for reasons not known at this time. Groups may not have stayed at the higher locations long enough to repeatedly resharpen tools there.

There are other indications of intensive reduction. As the total number of cores increases the total number of flakes increases (rank order = 0.910) and average flake size decreases (–0.714). Again, these relationships indicate the tremendous stress on lithic raw material that occurred at these sites, and also the fact that very little was transported off site. In addition, as the number of tools increases, the percentage of amorphous cores also increases. This suggests amorphous cores were created when there was more reduction in an assemblage and possibly the need for flakes required the utilization of poor quality raw material. Amorphous cores are inefficient, and their use suggests stress on raw material. They are usually some of the largest cores in the sample but produce some of the smallest flakes at the time of discard (Tables 18 and 19).

The tool components at each site are interesting more for what they do not correlate with than for what they do. Average tool size is not correlated with any core type frequency, total core frequency, average flake size, average cortical flake size, or total number of flakes. As would be expected, tool size is negatively correlated with retouch intensity (R = 0.87). Tools were repeatedly resharpened and reduced.

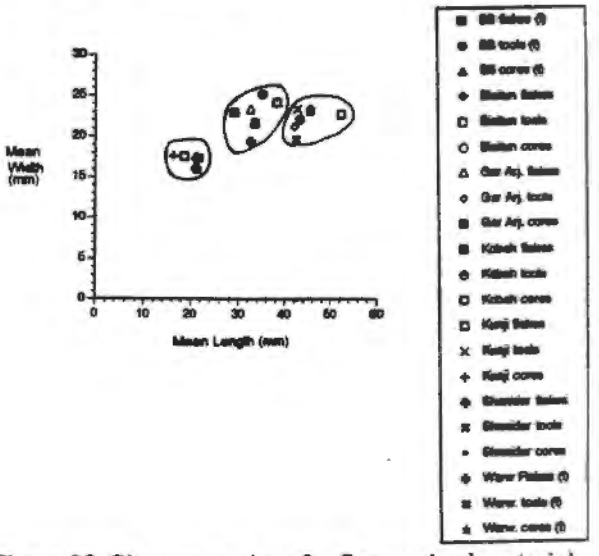


Figure 28. Size comparison for fine-grained material.

As average tool size increases, so does the percentage of truncated/faceted cores (rank order = .80). Again, if large blanks are available, the truncated/faceted technique will be used to produce expedient flakes.

The unretouched fine-grained blanks that remain in these assemblages, regardless of dorsal scar pattern, are

smaller in general than the heavily reduced tools (Figure 28). Naturally backed (Bordes' type 38) pieces are similar in size or smaller than single scrapers, suggesting that they either were too small to be selected for retouch or were not resharpened after they were used (Table 14).

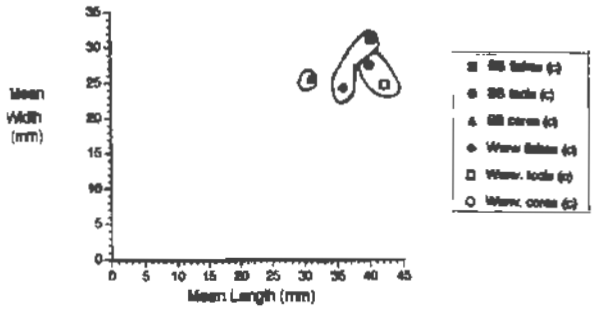


Figure 29. Size comparison for coarse-grained material.

The last removals from the cores are much smaller than either the flakes or tools in the samples studied (see Figure 28). All of the above strongly indicate core and raw material exhaustion (Barton 1988, 1990; Henry 1989:141). The tools recovered from these sites were used again and again. The cores were reduced to the point where the reduction strategy was changed from a longitudinal technique to a centripetal technique or, if flakes were plentiful, to a truncated/faceted technique in order to extend the use-life of the raw material.

The coarse-grained component is quite different. The core facets at Barda Balka are smaller than either the flakes or the tools, but the flake and tool components overlap somewhat (Figure 29). The width of tools at Warwasi is the same as in the unretouched flake component. Whereas, the length of the coarse-grained tools Barda Balka is the same. The decrease in width at Barda Balka is almost assuredly due to the heavy resharpening of single scrapers at the site (Table 11). The decrease in length at Warwasi is more perplexing because the majority of the small sample of tools are also single scrapers and there is a lack of heavily reduced types (i.e., double and convergent scrapers).

The tool-to-core ratios at some Zagros Mousterian sites are quite varied (Table 22). In fact, no cores at all were recovered from Hazar Merd unless the three so-called discs are actually centripetal cores (Garrod 1930:33). These values range from 1.04 tools per core at Barda Balka for the fine-grained component to 83 at Hazar Merd (if the three discs are included) and 36.9 tools per core for the 1969 excavation at Kunji Cave (Baumler and Speth 1993).

The flake-to-core ratios are equally variable for these sites (Table 22). The values range from highs of 42.6 flakes per core at Bisitun (taken from Coon 1951: Table 1A) and 33.7 at Kunji (Baumler and Speth 1993) to low values of 1.1 at Shanidar (Akazawa 1975), 1.0 at Bisitun (my count), 1.2 at Bisitun (Dibble 1984b), and 1.4 flakes per core (my count) at Barda Balka (fine-grained component). In some cases, there are insufficient cores to account for the flakes in an assemblage (e.g., Bisitun, Coon 1951; Kunji—1969 excavation; Hazar Merd; Houmian). At other sites (e.g., Barda Balka, fine-grained component; Bisitun [my count]; Gar Arjeneh; possibly Shanidar; Warwasi) there are more cores than is reflected in the flake count.

The flake-to-tool ratios at these sites also vary a great deal (Table 22). In some assemblages there are a high number of tools relative to flakes, and in others there are fewer tools. These values range from highs of

Table 22. Artifact ratios for Zagros Middle Paleolithic sites.

Site	Reference	Flake/Core	Tool/Core	Flake/Tool
Barda Balka fine-grained		1.47	1.04	1.41
Barda Balka coarse-grained		4.9	1.84	2.65
Shanidar		n/a	n/a	2.52
Shanidar	Akazawa 1975	1.1	5.5	0.2
Gar Arjeneh		2.66	4.09	0.65
Kunji		2.8	10.5	0.26
Kunji	Baumler and Speth 1993	33.7	36.9	0.91
Kobeh		3.4	2.6	1.3
Bisitun		1	2.2	0.45
Bisitun	Dibble 1984	1.2	4.9	4.1
Bisitun	Coon 1951	42.6	8.5	5.1
Warwasi		3.4	0.52	3.4
Warwasi	Dibble and Holdaway 1993	4.5	1.6	2.3
Houmian	Bewley 1984	17.7	4.2	4.1
Hazar Merd	Garrod 1930	n/a	83	n/a

4.1 flakes per tool at Houmian (Bewley 1984) and 5.1 flakes per tool at Bisitun (Coon 1951: Table 1a) to lows of 0.65 flakes per tool at Gar Arjeneh (my count), 0.26 at Kunji (my count), and 0.2 flakes per tool at Shanidar (Akazawa 1975). The average for all these sites is a flake-to-tool ratio of 2.2, and if the Bisitun ratio is removed (due to collection bias) the average is 1.8 flakes to every tool. There is a clear dichotomy between sites with heavily resharpened assemblages (Barda Balka-fine, Gar Arjeneh, Shanidar, Kunji, and Kobeh) and those with less reduced assemblages (Barda Balka-coarse, Bisitun, Houmian, and Warwasi). These data suggest a varying degree of maintenance of the available raw material in this region. Even at sites where there is a high flake-to-core ratio, as at Bisitun, Kunji, Houmian or Warwasi, there is a low flake-to-tool ratio. Some sites even have fewer flakes than tools in the sample (although this could be due to collection bias as well).

The reasons for these differences in core frequency are not clear, but the evidence suggests either differential patterns of transporting cores or flakes and tools or differential recovery by the excavators of the sites. It is also conceivable that the test excavations at some of the caves simply sampled parts of sites that were "core poor" or "core rich" and that these differences would even out if these sites were excavated in their entirety. Using a Euclidean distance coefficient to cluster the sites based on frequencies of flakes, tools, and cores produces two groups. The first group is composed of Kunji, Gar Arjeneh (both excavated by Hole and Flannery), and Bisitun (excavated by Coon), and the second group is composed of Barda Balka, Kobeh, and Warwasi (all excavated by Howe) and Shanidar (excavated by the Soleckis). While these results may suggest some excavator bias, it should also be noted that each group of sites is, by and large (except Bisitun), located in a separate area of the Zagros Mountains, and the local conditions could also be affecting the lithic technology.

What this means in terms of behavior and the organization of lithic technology must begin and end with reduction and rejuvenation of tools. There is no question that the technology of the Zagros Mousterian revolves around the stretching of raw material resources. Retouch intensity values for the Zagros Mousterian sites analyzed here averaged .843 for fine-grained raw material and .882 for coarse-grained raw material. In contrast, these same values average .642 from the Levantine Mousterian. The difference in the degree of reduction between these two regions suggests more intense utilization of raw material in the Zagros Mountains. The question of why these resources needed to be more heavily used in this area is more difficult to address (see Chapter 11).

The question of whether all of this reduction took place at the sites can be answered by examining the relationships between flake types at these sites. The flake sample indicates that length of cortical flakes is related to length of longitudinal flakes at every assemblage but Kunji and Bisitun ($R = 0.88$). In other words, cortical flakes are longer than, and in terms of production could have preceded, longitudinal flakes at these sites. The Kunji sample has cortical flakes that are much shorter than the longitudinal pieces, but the sample is small. Bisitun has much longer cortical flakes than longitudinal pieces, but this sample is highly selective. In addition, the average length of longitudinal flakes is related to the length of centripetal pieces at all sites ($R = 0.79$). These results suggest that a complete reduction trajectory occurred at every Zagros Mousterian site, accept perhaps Kunji.

The tool sample also indicates a succession of retouch at each site. The width of single scrapers is related to the width of double scrapers ($R = 0.74$). When Gar Arjeneh is deleted from the analysis (because these two scraper types have the same average width), the relationship is stronger ($R = 0.90$). In addition, the length of convergent scrapers is related to the length of double scrapers ($R = 0.80$). If Bisitun is deleted from the analysis because of sample problems, this relationship is very strong ($R = 0.97$). The width of the single scrapers predicts the width of the double scrapers that follow. In addition, the length of double scrapers predicts the length of convergent types. These results indicate that there was a retouch progression from single to double to convergent scrapers at these sites. Width decreases as single scrapers are retouched and another side is added, producing double types. Length decreases as doubles are further retouched into convergent scrapers.

This technology is related to the environment and elevation of the Zagros region. Fine-grained radiolarite pebbles are patchy in distribution (Bruce Howe, personal communication 1991). Their small size coupled with the seasonal time stress placed by the environment on the occupation of these sites, along with isolated snow cover, could have fostered a conservation of the available raw material. The use of local quartzite at Barda Balka and Warwasi also indicates a scarcity of fine-grained raw material. In addition, the transport of cores, and also possibly tools, around the landscape hints at the need for the conservation of usable stone when these Mousterian populations were moving up and down the mountain ranges.

10

Comparisons with Other Regions in Southwest Asia and the Transcaucasus

The Middle Paleolithic of surrounding regions is compared with the Zagros Mousterian in this chapter in order to document and explain the technological diversity that existed for this period in southwest and central Asia.

The Levant

The Zagros Mousterian is most often compared with the Middle Paleolithic industries of the Levant (Dibble and Holdaway 1993; Garrod 1930; Skinner 1965; Smith 1986). There is historical precedence for this, as Garrod excavated in Palestine (1928) before turning to the Zagros (1930), so it was natural for her to compare the industries. She thought the industry at Hazar Merd had "marked affinities" with those at Zuttiyeh and Shukba. The characteristics shared by both industries were a large proportion of blades and narrow tools along with the presence of a "flat retouch" and "typical gravers." Since the material from Hazar Merd was not examined for this study, these observations cannot be specifically addressed. Succeeding excavations and analyses used Hazar Merd as the "type site" with which new assemblages from the Zagros Mousterian were compared (Coon 1957; McBurney 1964; Solecki 1955). However, the general view of the Zagros Mousterian has changed somewhat over the years, leading to a clear differentiation of these industries from the Levantine Mousterian (Skinner 1965). There are good reasons for this based on differences in technological and typological characteristics of the lithic assemblages. The results of my analysis also indicate a clear difference between the degree of resharpening and overall technology of these regions.

Technology

In the Levant, Middle Paleolithic assemblages have been separated into consecutive chrono-cultural industrial phases based on unretouched flake blank shape and tool frequencies found at the type site of et-Tabun, on Mount Carmel in Israel. Most workers now recognize three phases, although the terminology used to identify them has changed over the years and is not entirely consistent (cf. Copeland 1975; Jelinek 1981, 1982a, 1982b; Marks 1988).

The early Levantine Mousterian (Phase 1) is characterized by unidirectional and bidirectional (i.e., longitudinal) core preparation that produced blades and elongated Levallois points, and "Upper Paleolithic" tool types like burins and endscrapers. This phase has been found in the northern and central Levant at cave and rockshelter sites like Tabun layer D, Jabrud, Abou Sif (Copeland 1975), Jerf Ajla (Schroeder 1969), Doura layer IV (Nishiaki 1989), Ksar Akil level 28 (Marks and Volkman 1986), Nahr Ibrahim (northern gallery) (Solecki 1975), and at open sites and rockshelters in the southern Levant such as Rosh Ein Mor in the central Negev highlands (Crew 1976), Tor Sabiha (Henry 1982, 1994), and Ain Difla (Lindly and Clark 1987) in southern Jordan. An industry morphologically related to Tabun D occurs in the same stratigraphic position (above the Mugharan Tradition or Acheulo-Yabrudian) at some northern sites in the El-Kowm basin, Syria (Copeland and Hours 1983; Hours 1982). This industry, known as the Hummalian, is also characterized by blades and elongated points but is argued to be sufficiently different technologically (no Levallois technique) from Tabun D to warrant another name.

Phase 2 Mousterian, found in layer C at Tabun, is characterized by radial core preparation (centripetal) producing broad, oval Levallois flakes; a low percentage of points; and "classic" Mousterian tools such as flake side scrapers. The sites of Qafzeh (Vandermeersch 1966, 1981, 1989), Skhul (Boutié 1979), Naame (Fleisch 1970), Ras el-Kelb (Garrod and Henri-Martin 1961), and Nahr Ibrahim-central gallery (Solecki 1975) also have assemblages characterized by radial core reduction, oval Levallois flakes, and side scrapers. These sites are located, for the most part, in the central and northern coastal regions of the Levant. No Tabun C–type site has been discovered in the southern Levant.

The "final" Phase 3 Mousterian, identified at Tabun, layer B, is known from collections made by Garrod and is characterized by unidirectional and radial core preparation producing narrow forms and short, broad-based Levallois points (Copeland 1975). Phase 3 is frequently combined with Phase 2 (i.e., Phase 2/3) by workers like Copeland (e.g., 1983) and Jelinek (1981, 1982a, 1982b) because of an inadequate description of layer B at the type site. This problem has since been resolved by the description of the lithic assemblage at

Kebara Cave as Tabun B-like with unidirectional convergent (longitudinal) core preparation and the production of numerous short, squat points (Bar-Yosef et al. 1992). Other sites that fall into this category are Bezez Cave layer B (Copeland 1983), Keoue Cave (Nishiaki 1992), Amud cave (Suzuki and Takai 1970; Ohnuma 1992) and possibly Tor Faraj in southern Jordan (Henry 1982; Henry et al. 1996).

The location of the Tabun B industrial facies in both northern and southern parts of the Levant, like the Phase 1/Tabun D–type industries is interesting. The evidence for a wetter climate than today during the deposition at Tor Faraj (Henry et al. 1996:50) and a similar Mediterranean climatic regime during the early Mousterian at Rosh Ein Mor in the Negev may indicate that the southern Levant could only be occupied during milder climatic episodes. It is possible that Tabun C–type or Phase 2 Mousterian industries are not found in the southern Levant because there was no occupation of this region during this period owing to severe climatic conditions.

Although there is a technological basis for classifying Mousterian sites in the Levant into these three categories, not all sites can be categorized using this system. Quneitra (Goren-Inbar 1990) and Fara II (Gilead 1988) contain industries that are different in many ways from those found within the Tabun sequence, and it is quite possible that there is a greater variety of industries than those described above. The problem is one of attempting to use a sequence from a single site (i.e., et-Tabun, Mt. Carmel, Israel) as the basis for classifying or pigeonholing every industry in a region.

It is unreasonable to assume that any site, even one as large and stratigraphically rich as Tabun, would contain every industrial facies or variation within a region. The type site concept is an old one (see Chapter 2). It is based on the belief that every site in a region should contain all or part of the same industrial sequence from that region based on the idea that "culture" determines assemblage form and content. There has never been any documented instance where this has occurred in any region of the world. Therefore, constructing a regional industrial sequence of development based on the industries found at one site is misleading and counterproductive to an understanding of the lithic industrial history in an area. However, for the basis of the discussion in this chapter, I will refer to these three industrial groupings from Tabun as a *lingua franca* to roughly categorize Levantine Middle Paleolithic sites.

Up until now, no industrial sequences have been identified in the Zagros Mousterian, nor should we expect one given the tremendous number of technological choices and strategies available to Middle Paleolithic hominids in this, or any other, region. Zagros Mousterian assemblages are quite different from Levantine Mousterian industries, appearing to be more homogeneous, but perhaps not as much as previously thought. In addition, different factors influence assemblage variability in each region. For instance, in the Zagros, resharpening and rejuvenation affected the character of the industries to the exclusion of nearly everything else. In the Levant, changes in core reduction affected the character of the industries (see typology section below). No matter what type of flake was created in the Zagros, the repeated resharpening of that flake was going to result in only certain types of discarded tools. In the Levant, a blade technology produced a preponderance of blades and point forms and blade-point debitage. This limited the types of tools that would be found—end scrapers, burins, backed blades, points, etc. (see Barton 1990). A Levallois flake technology produced Levallois flakes and flake debitage. This in turn favored the creation of side scrapers. If raw material was large, plentiful, and fine-grained, then rejuvenation became unnecessary or less infrequent. The Levantine Mousterian blanks were resharpened less than in the Zagros because raw material was large and fairly plentiful in the Levant

Previous Metrical Analyses

Jelinek (1982) utilized variances in the width-to-thickness ratios of complete flakes and length-to-width ratios of Levallois points to demonstrate stratigraphic trends in technology at Tabun (Tables 23 and 24). Whole flakes became increasingly thin through time while Levallois points become less elongated. Jelinek was able to show that this pattern existed for other Middle Paleolithic sites in the Levant and that Tabun D–type sites and Tabun B/C–type sites contained different kinds of flakes and points, at least in the central and northern Levant.

Henry (1992) suggested a similar pattern within "arid zone sites" in the southern Levant. These sites have all been classified as Tabun D-like industries, and Henry saw a clear time trend in the variance of width-to-thickness ratios related to the continuation of Tabun D–type industries in the southern Levant throughout the Middle Paleolithic period. In other words, these industries also showed a trend toward thinner flakes through time, mirroring what was happening in the Mediterranean zone of the central and northern Levant without the same technological changes associated with Tabun D–type, C-type, and B-type industries. There was no shift from blades-points to oval flakes back to short blades-points in the southern Levant. A blade-point industry existed throughout the Mousterian in these southern regions. Henry (1992) also argued that the length-to-width ratio of Levallois points in the southern arid zone sites did not show the same trend toward less elongation through time that is seen in the more northern Mediterranean zone sites.

Along with metrical variability, the Levantine assemblages show technological trends through time.

Table 23. Width/Thickness ratios for complete flakes from Phase 1 and Phase 2–3 Mousterian sites in the Levant (from Jelinek 1982).

	Mean	Median	Variance	N
Phase 1 MP				
Tabun IX	4.248	3.999	3.128	743
Rosh Ein Mor	4.436	4.111	4.236	373
Nahal Aquev	4.925	4.716	3.902	332
Abou Sif B	4.51	4.002	3.342	214
Abou Sif C	4.126	3.875	1.732	173
Phase 2–3 MP				
Tabun Unit 1	4.633	4.249	5.049	1377
Kebara F (3)	5.891	5.332	7.129	604
Kebara F (5)	5.962	5.496	7.604	628
Kebara F (8)	6.293	5.668	8.166	539
Shukbah D	5.63	5.204	6.302	484
Qafzeh I	6.476	5.802	7.974	661
Qafzeh L	7.034	6.502	9.508	573

Table 24. Length/Width ratios for complete Levallois points from Phase 1 and Phase 2–3 Mousterian sites in the Levant (from Jelinek 1982).

	Mean	Median	% Elongated	N
Phase 1 MP				
Tabun IX	2.45	2.33	34.1	179
Rosh Ein Mor	2.41	2.39	36.4	11
Nahal Aquev	2.48	2.48	28.2	39
Abou Sif B	2.7	2.57	43.4	76
Abou Sif C	2.69	2.67	40	50
Phase 2–3 MP				
Tabun I:1–17	2.27	2.19	24.6	30
Tabun I:18–26	2.07	2.07	14.1	35
Kebara F (3)	2.12	2.03	12.5	56
Kebara F (5)	1.94	1.8	10.8	37
Kebara F (8)	2.07	1.91	14.3	63
Shukbah D	2.29	2.18	22	173
Qafzeh I	2.17	2.03	16.1	112
Qafzeh L	2.18	2.19	17.3	81

Marks (1983) has noted a shift from unidirectional to bidirectional flaking of Levallois points through time within the Tabun D-type assemblages in the southern Levant. The proposed early Mousterian site of Rosh Ein Mor has very little (2.7%) bidirectional flaking of points, whereas at the very late Mousterian/Upper Paleolithic site of Boker Tachtit an overwhelming percentage of the points is flaked from opposed platform cores (95.2%). Henry (1992) suggested the sites of Tor Sabiha and Tor Faraj were intermediate between these two sites in both age and percentage of bidirectional flaking of Levallois points. Whether or not this technological typology is accurate depends a great deal on how accurate the dating of these sites has been. It is clear that changes in technology can occur repeatedly through time because of changes in settlement-subsistence structure. For example, the percentage of bidirectional Levallois points changes within the Tor Faraj assemblages from more to less to more again. Such a trend through time is difficult to explain in terms of the evolving technology and motor skills of hominids through time.

The Zagros Mousterian does not appear to follow the same temporal trend of progressively thinner flakes, at least as far as we can monitor relative time

stratigraphically. The four groups of stratigraphic levels analyzed at Warwasi by Dibble and Holdaway (1993) show no real metrical differences among them. In addition, there are no noticeable changes in frequency of uni- versus bidirectional flaking from the bottom to the top of the sequence. Perhaps the known sample of Zagros Mousterian assemblages covers a shorter period of time, the populations did not experience the same selective pressure on technology and consequent flake morphology, or technological variability was more restricted by raw material size and shape than in the Levant. In any case, the causal factors that promoted these changes in the Levant do not appear to have existed in the Zagros region. Changes in settlement-subsistence systems, including differences in mobility and land use, would cause technological changes like those we see in the Levant as populations attempted to cope with concurrent changes in raw material availability and resource versus tool availability, and raw material stress.

Typology

Typological comparisons within the Levantine Mousterian reveal more differences between the Levant and the Zagros regions.

Marks (1992) has recently attempted to compare Levantine Mousterian lithic assemblages in terms of typology, arguing that much information is being ignored regarding the retouched tools in these industries because of a technological bias in the research tradition of the region. By comparing the percentages of Upper Paleolithic tool types, Middle Paleolithic tool types, and denticulates in Levantine Mousterian assemblages, Marks was able to demonstrate several interesting typological aspects of these industries independent of their technological attributes. First, the denticulate component of these industries accounted for or explained the least amount of variability. This is consistent with the results of similar comparisons for Europe, where the frequency of denticulates and notches stays more or less the same and the frequency of scrapers accounts for the majority of variability in Middle Paleolithic industries (Dibble 1987; Dibble and Rolland 1992; Holdaway et al. 1996; Rolland 1981; Rolland and Dibble 1990). In the Levantine Mousterian, the two tool classes that account for most of the typological variability in assemblages are the "Upper Paleolithic" tool group and the "Middle Paleolithic" tool group. Marks (1992:133) found that, with few exceptions, these two groups corresponded with the early and late Levantine Mousterian, respectively. This grouping can be easily explained in terms of technology.

The early Levantine Mousterian was based primarily on a blade technology, and most tools manufactured on those blanks were constrained into "Upper Paleolithic" types, such as end scrapers or burins. Conversely, the late Levantine Mousterian contained core reduction strategies that produced primarily flakes or flakes, and squat points and blades and side scrapers would have been most easily made on those blanks (see Barton 1990).

An interesting aspect of Marks's study is the presence of assemblages that do not classify as expected. For example, Tabun unit IX (layer D), the type site and layer for the early Levantine Mousterian (Jelinek 1975, 1981, 1982), and Bezez B (Copeland 1983), both classified on technological grounds as early, are classified on typological grounds as late, i.e., containing more side scrapers than expected. Marks explains this discrepancy in terms of intensity of occupation of these cave sites, which promoted more intensive tool use and therefore more intensive reduction, although he points out that at Tabun the tools and/or blanks were probably transported from elsewhere, as there is little evidence for core reduction at the site. This still does not explain the presence of relatively numerous side scrapers made on flakes at sites supposedly dominated by a blade technology. At present, there is no satisfactory explanation for this discrepancy.

In late Levantine Middle Paleolithic assemblages, the typological variation is less consistent. Nearly all the variability noted is between shifting percentages of Upper versus Middle Paleolithic tool types. Interestingly, there are several sites where denticulates are the dominant tool type with a general absence of other retouched tools (e.g., Gilead and Grigson 1984).

It is clear that blank type and shape, site function(s), mobility patterns, and raw material availability can all theoretically reflect and affect patterns in tool manufacture, resharpening, use, and discard. In the case of tool typology, blank type and shape affect the position of the retouch that can be most readily applied. For example, end scrapers and burins are difficult to make on a large oval Levallois flake (Barton et al. 1996). Conversely, a side scraper would be awkward to make on a blade and would yield an end result that (1) is difficult and potentially dangerous to handle while scraping an object, (2) is limited in resharpening potential, and (3) is more than likely not an efficient tool (ibid.). Technology affects typology in these situations.

Zagros Mousterian sites are typologically very similar to one another except for the open site of Barda Balka, where denticulates and notches are more frequent than scrapers. In addition, the Zagros industries as a group are typologically very different from the Levantine assemblages because of the large amount of resharpening that occurs in the Zagros assemblages.

Seasonality

Recently, differences in site use at certain Middle Paleolithic sites in the Levant have been suggested (Lieberman 1993; Lieberman and Shea 1994). Using cementum analysis of ungulate teeth, Lieberman argues that some late Middle Paleolithic sites show

"multiseasonal occupation" in contrast to late early Middle Paleolithic and Upper Paleolithic sites, which are argued to have been occupied only during part of the year.

The supposed multiseasonal occupations of Kebara and Tabun B also are characterized by a large percentage of Levallois points in the lithic assemblage. Qafzeh XVII–XXIV and Tabun C have low percentages of points and cementum evidence of single-season occupations.

As discussed in Chapter 6, Levallois points are argued by Shea to have been used as tips for projectiles based on the "high" incidence of impact damage. Impact damage, which occurs on no other artifacts in the assemblages, is presented as conclusive evidence for hunting.

Lieberman and Shea (1994) utilize the radiating versus circulating settlement pattern to explain the evidence from these sites (Marks and Freidel 1977). To reiterate, in a radiating pattern a few large residential settlements are surrounded by limited activity locations. Residential mobility is low and logistical mobility is high. In contrast, a circulating pattern creates numerous small residential sites stemming from high residential mobility and little logistical mobility.

Lieberman and Shea (1994) suggest that sites with evidence of multiseasonal occupation and a high percentage of Levallois points are the large residential base camps within a radiating settlement system. Increased hunting is theoretically necessary in order to maintain the system of more intensive land use. Sites without points in a different time period are argued to be part of a circulating system where hunting is less important (ibid.).

There are a few problems with these arguments. First, the sample of sites analyzed is small and restricted to cave/rockshelter locations. With only two sites analyzed per period, how do we know, for example, that there are no sites with a low percentage of points that experienced multiseasonal occupation or sites with numerous Levallois points only occupied for part of the year? In addition, at Tabun B the absence of hearths clearly rules it out as a "large residential base," but there were points, and animals were killed and processed there, as would occur at a logistical site. In the case of Tabun B, this location was apparently used at different times of the year.

Second, the sample sizes from each site are small, and despite assurances to the contrary, potentially huge time periods are perhaps being lumped together. For instance, 1,000 years of a series of dry-period occupations followed by 1,000 years of wet-period occupations at Kebara would appear archaeologically to represent multiseasonal occupation of a radiating/collector settlement system even though the opposite was true. Theoretically, site function can change radically from year to year and from season to season (Binford 1982). The Paleolithic archaeological record cannot be dissected in a sufficiently fine-grained manner to determine this. In addition, these data reflect, in a coarse-grained way, what is going on at specific locations and should not be generalized to extremely long periods of time or chrono-stratigraphic industrial facies.

Third, as discussed above, Shea's arguments for Levallois points being tips for projectiles ignore data to the contrary (Holdaway 1989; Kuhn 1989). Fewer than 25% of the points recovered from Kebara, Tabun B, and Qafzeh XV show impact damage (Lieberman and Shea 1994:315). Shea's insistence that impact damage is confined to Levallois points is interesting, but it is far from certain that this kind of damage could only occur if a point had been launched at ungulate prey. Tip damage on a convergent-edged tool created or selected to have this tip should not evoke a great deal if astonishment. Nor should the fact that other artifacts in the same assemblage that do not have a pointed tip show no such damage. In most cases, we can assume that a Levallois point was manufactured on purpose or at the very least selected because of the usefulness of the pointed end and also that a pointed tool being wedged and jammed into a carcass during processing will be damaged at the tip on occasion. In addition, as a rule, a great deal of hunting is associated with high mobility (Kelly 1983), rather than year-round occupation.

Fourth, these data ignore all the Tabun D–type sites in the Levant that are dominated by Levallois points. Are all these sites indicative of a major emphasis on hunting wherever this industrial facies is found?

The Zagros Middle Paleolithic would benefit from a seasonality study if only to confirm or refute an assumed summer occupation for all of the sites. The projectile point/functional artifact shape versus pointed tool/resharpening progression argument rages on about the Zagros artifacts as well (see Solecki and Solecki 1993). The differences, for the most part, between pointed artifacts in the Levantine Mousterian and those in the Zagros Mousterian are due to resharpening in the latter industries.

In the Levant, Levallois points are manufactured as pointed blanks in a specific reduction sequence and many of them are not resharpened intensively. In contrast, Zagros convergent scrapers/Mousterian points are retouched/resharpened into pointed artifacts. They may or may not have been pointed flake blanks to begin with (however, see Solecki and Solecki 1993:129). In both regions, the evidence that convergent-edged "tools," whether manufactured or retouched, were being used as projectile points is weak.

Regional Comparison of Technological Attributes

A detailed comparison of the lithic technology of the Zagros and the Levantine Mousterian is beyond the scope of this study. However, using data collected by the author, these industries can be compared in a limited

Table 25. Comparison of flakes and tools from the Zagros and Levantine Mousterian.

	N	Length	Width	Thickness	Platform Width	Platform Thickness	Flake Area	Platform Area
All Flakes								
Zagros	2297	34.6	22.4	5.9	14.2	4.4	820.8	78.7
Levant type C	904	45.8	29.8	6.7	19.6	5.1	1469.8	117.4
Levant type D	2286	50.1	28	6.5	19.4	5.3	1471	117.6
Centripetal								
Zagros	187	33.4	25.2	6	16.8	4.6	917.6	95.9
Levant type C	320	49.4	32.7	6.9	21.1	5.3	1762.1	128.5
Levant type D	285	49.3	30.6	7.2	18.6	5.2	1600.2	113.3
Longitudinal								
Zagros	1763	34.2	21.5	5.5	13.8	4.3	767.5	72.2
Levant type C	558	43.8	28	6.5	18.8	5	1294.7	110.7
Levant type D	1935	50.2	27.6	6.4	19.6	5.3	1451.6	118.9
Tools								
Zagros	1651	43.2	23.1	7.5	14.9	5.2	1014.6	90.7
Levant type C	224	58.4	35.1	8.3	23.2	6.2	2136.5	158.9
Levant type D	446	59.2	28.8	7.7	19.5	5.9	1745.1	127.4

Table 25. (continued)

	N	Length/ Width	W/Th Mean	W/Th Variance	Retouch Intensity
All Flakes					
Zagros	2297	1.708	4.315	3.155	—
Levant type C	904	1.62	4.988	3.551	—
Levant type D	2286	1.928	4.855	4.497	—
Centripetal					
Zagros	187	1.394	4.698	2.498	—
Levant type C	320	1.584	5.204	3.764	—
Levant type D	285	1.741	4.781	3.565	—
Longitudinal					
Zagros	1763	1.753	4.408	3.216	—
Levant type C	558	1.652	4.91	3.433	—
Levant type D	1935	1.953	4.884	2.152	-
Tools					
Zagros	1651	2.012	3.416	1.736	0.845
Levant type C	224	1.746	4.591	2.848	0.577
Levant type D	446	2.209	4.139	2.529	0.69

manner to assess general similarities and differences between these regions.

The products of Zagros Mousterian industries are, all things being equal, smaller than those found in the Levant (Table 25). These differences can be related to the different raw materials available in each region. An industry utilizing small pebbles will produce smaller by-products than one using larger cobbles and tabular raw material. However, the Zagros industries are very similar in length-to-width ratios and width-to-thickness ratios to both C-type and D-type industries from the Levant (Table 25). These data indicate that although the flakes are smaller in overall dimensions in the Zagros, they are of a similar shape, especially the length-to-width of the longitudinal component and the width-to-thickness of the centripetal component. These data point to a similar reduction strategy being employed in both regions and to raw material differences as the cause of the differences between the regions. Further, both regions are dominated by assemblages that have the majority of dorsal scar patterning originating from the proximal end, or Baumler's (1988) grid area 1 (Table 25; Figure 16).

Table 25. (continued)

	N	% Plain Platform	% Faceted Platform	% Cortical Platform	% No Cortex
All Flakes					
Zagros	2297	44.5	33.1	6	69
Levant type C	904	22.2	48	4.4	66
Levant type D	2286	29.2	43.4	3.8	60.9

	N	% Scar 1	% Scar 2	% Scar 3	% Scar 4
All Flakes					
Zagros	2297	86	22	23	21
Levant type C	904	89	38	38	33
Levant type D	2286	93	25	16	24

	N	% Cortex Loc. 1	% Cortex Loc. 2	% Cortex Loc. 3	% Cortex Loc. 4
All Flakes					
Zagros	2297	12	20	18	12
Levant type C	904	12	21	20	13
Levant type D	2286	12	22	24	13

Tabun C–type assemblages have a higher percentage of flake scars originating in the other three quadrants than do either Tabun D–type or Zagros assemblages, but this is to be expected because of the large number of centripetal flakes associated with C-type industries. In addition, the pattern of cortex location is nearly identical between assemblages from the Zagros and Levant and within the Levant itself (Table 25). The percentage of cortex left on flakes is lower on the proximal end of the blanks, a condition not entirely unexpected given the dorsal scar data described previously.

In the Levant, the centripetal component is longer and wider in the C-type industries but slightly shorter in the D-type industries relative to the longitudinal component (Table 25). Further investigation is needed to determine if centripetal flakes preceded longitudinal flakes in Levantine Mousterian industries as in the Zagros. Platform data indicate this may be the case.

Platform length and width are smaller for Zagros flakes, in keeping with the overall smaller flake size. C-type industries have the largest platforms associated with centripetal industries, whereas D-type industries have larger platform dimensions in the longitudinal industries. In addition, the Zagros industries have higher percentages of plain platforms than those from the Levant, and there are more non-cortical flakes in the Zagros samples. This could be related to the smaller size and greater reduction of the raw material in the Zagros region, but this will need to be tested further.

Retouch intensity values for the tools in both regions are very different (Table 25). It is not surprising that the Zagros tools have higher values and more intensive resharpening than the Levantine tools. What is surprising is that, on average, Tabun D–type industries have been retouched more intensively than Tabun C–type industries.

As might be expected, the Zagros Mousterian cores are smaller than those from the Levant in nearly every dimension (Table 26). However, centripetal types from the Zagros are thicker than these types from the Levant, and this translates into a larger average core size. The Zagros cores have a higher percentage of non-cortical cores too, followed by C-type and then D-type industries.

Skinner (1965) separated the Zagros and Levantine Mousterian industries based on typological comparisons between these regions. The technological comparison presented above also demonstrates that these industries are very different from one another. These differences do not necessarily rule out interaction between these regions, but they do demonstrate how raw material and site function can affect the technology and typology of lithic industries.

Summary

Comparisons of the Zagros and Levantine Mousterian are interesting because of the relatively close proximity of these regions. It is clear that different things are going on in each region. The Levant has a larger sample of excavated sites which probably includes an entire series of site types from base camp locations and limited activity sites to quarries and hunting camps. The Zagros sites analyzed in this study appear to be similar in

Table 26. Comparison of cores from the Zagros and Levantine Mousterian.

	N	Length	Width	Thickness	Facet Length	Facet Width	Facet Area	Average Core Size	Length/ Width	% No Cortex
All Cores										
Zagros	795	35.9	32.6	16.6	21.4	17.4	403.9	29,026.3	1.1	30.2
Levant type C	169	42.4	39.2	17.3	24.7	20.3	527.5	33,486.2	1.1	27.2
Levant type D	301	49.9	43.2	19.8	30.5	21.1	675.9	47,428.8	1.2	23.3
Centripetal										
Zagros	181	37.6	34.9	17.1	22.4	18.5	449.7	34,444.6	1.1	—
Levant type C	46	40.9	40.8	16.1	24.8	21.9	559.7	28,639.3	1	—
Levant type D	51	50.2	46.7	21.3	30.9	23.1	731.9	53,289.1	1.1	—
Longitudinal										
Zagros	373	35.7	34	18.6	22.1	18.5	442.1	31,231.9	1.1	–
Levant type C	73	42	38.2	19.1	24.9	20	531.3	37,498.8	1.1	—
Levant type D	121	48.1	43.2	22.5	32.5	21.8	738.1	52,454.7	1.2	—

technological makeup and, along with the environmental, faunal, and geographical data, present a picture of primarily single-season, short-occupation hunting/base camps by small groups of people. The contrasts between these regions, however, can be related almost exclusively to differences in raw material and intensity of use rather than any serious differences in core reduction technology. This is interesting because, from what we know about these areas, there was a tremendous diversity of adaptations to different environments and elevations by archaic hominids in Southwest Asia.

Northwest Caucasus and Central Asia

The other region most often compared with the Zagros is the region north of modern-day Iraq and Iran along the Caucasus Mountains, an area made up of Azerbaijan, Armenia, Georgia, and southern Russia (Garrod 1938; Solecki 1963; McBurney 1964). This region has the same montane ecosystem as the Zagros region, making comparisons more realistic than with the Levant.

The archaeology of Transcaucasia has been studied since the end of the nineteenth century (Baryshnikov and Hoffecker 1994). Most of this region was under Soviet control until recently and therefore most of the work is published in Russian (and I could not read the originals). It is not my intent to produce a detailed study of the Middle Paleolithic archaeology of this region, but only to explore possible relationships to the Zagros region to the south. In general, the Middle Paleolithic stone assemblages in the Caucasus have been characterized by narrow scrapers and points, and there was a "significant" presence of Levallois technology (Smith 1986:37).

The following sites are located in the northwest Caucasus (Russia) near the Black Sea.

Il'skaya I and II

The site of Il'skaya I, near the village of Il'skii at 100 m above sea level (m asl), has a lithic assemblage composed of "typical" discoid (centripetal) or multidirectional cores produced on pebble raw material (Hoffecker et al. 1991:117). Some of the debitage still has cortex on the dorsal surface (34%), and the tools are dominated by single-edged side scrapers (33%) and "canted" types (10%) while Levallois technology is rare. Il'skaya II is located 150 m from the first site and contained isolated flakes and faunal remains, including those of mammoth (Baryshnikov and Hoffecker 1994:2).

Matuzka Cave

Matuzka Cave is located at 750 m asl near the village of Guamka. Lower levels (5–7) contained simple and transverse side scrapers. Layers 4b–4c contained scrapers and points. Layers 3b–4a contained Levallois blades and flakes, bifaces, and denticulates. Wild goat and red deer remains are found throughout the deposit, as is a significant proportion of cave bear remains.

Barakaevskaya Cave

This cave is located 900 m asl near the village of Barakaevskaya and contained a shallow (<1 m) but very rich deposit (>20,000 lithics and >80,000 animal bones) of Mousterian artifacts (Baryshnikov and Hoffecker 1994:4). The lithic assemblage contained more than 800 tools, including 277 sidescrapers, 244 notches, 43 denticulates and 29 points. Only 40 cores were recovered, most of them discoidal. At least some cores had to have been removed from the site given the large number of lithics produced. Also noteworthy is that denticulates and notched tools were recovered in near equal numbers to scrapers and points. Bison and wild goat/sheep dominate the faunal assemblage, suggesting a

subsistence range that included both montane and more open lower regions.

Mezmaiskaya Cave

This cave is located at 1350 m asl near the village of Dakhovskaya and contains a deep deposit (>4.5 m) that was subdivided by the excavators into seven levels. The stone artifacts recovered are labeled Mousterian and consist of sidescrapers, bifaces, and flakes. The faunal remains are predominantly wild goat/sheep and bison (Baryshnikov and Hoffecker 1994).

Summary of Northwest Caucasus Sites

The lithic raw material utilized and the presence or absence of Levallois at each of these Russian Caucasus sites was inconsistently reported. The faunal remains recovered are dominated by steppe bison (*Bison priscus*). The remainder of the faunal remains appear to reflect the presence/absence of certain species in the surrounding environment of the sites. Mammoth and giant deer are present at the lower sites (Il'skaya I and II) whereas goat and sheep are present at the higher sites (Matuzka, Barakaevskaya, Mezmaiskaya).

The quality and size of the pebble raw material available at these sites were not reported, nor were the sizes of the flakes, tools, or cores. It is clear, however, that lithic material (in the form of cores) was being transported around the landscape in the northwest Caucasus. The presence of bifaces (at Matuzka and Mezmaiskaya) is interesting in comparison with Hazar Merd and Barda Balka and reinforces this as a "normal" Middle Paleolithic tool type or core type in central and Southwest Asian lithic assemblages. It is of interest that there does not appear to be a major difference between the tools produced at low elevations versus those produced at high elevations. Raw material may be the same across this region and may have effectively limited the types of blanks produced.

This very cursory comparison of the northwest Caucasus sites with the Zagros Mousterian suggests that pebble raw material may have sufficiently constrained technology so as to produce similar lithic assemblages in both regions, and site location probably dictated the kind of prey species taken.

Teshik-Tash (Uzbekistan)

The site of Teshik-Tash has been linked technologically and typologically to the Zagros Mousterian sites and also to Ke-Aram I in northeastern Iran (McBurney 1964:393).

The site is located in the Gissar mountain range in southeastern Uzbekistan at 1,500 m asl (Movius 1953). Movius reported 2,520 lithic artifacts and more than 900 identifiable bones recovered from a test trench. There is little variability in content between the five layers defined by the excavators — only in the density of artifacts. The site is assigned to the last interglacial (Movius 1953) (approximately isotope substages 5e–5a) during milder environmental conditions. The faunal remains are dominated by goat.

The lithic assemblage is made from a "second-rate" dark gray, fine-grained siliceous limestone, a finer-grained yellow siliceous limestone, jasper, quartzite, and quartz (Movius 1953). The local gray limestone is found in large slabs and blocks and also as waterworn pebbles in the stream below the site. The nonlocal, much finer grained yellow limestone, jasper, quartz, and quartzite were all originally pebbles. The local and the nonlocal raw materials were exploited differently. This behavior contrasts with the results from the coarse-grained components of Barda Balka and Warwasi that were very similar to the fine-grained components recovered there. The difference could be due to the fact that both raw materials were "local."

The finer-grained limestone, jasper, and quartzite raw material was "utilized to the last bit" (Movius 1953:29). Cores are rare and exhausted; tools are resharpened and reused, including examples of broken "points" being resharpened into scrapers. Unused flakes are rare and are small.

The dark gray siliceous limestone, on the other hand, was extensively used to produce flakes at the site. Tools made from this material are not retouched as intensely as those of the finer-grained materials, and unused flakes are common. The two crude bifacial "hand-axe" tools are made from silicious limestone. In addition, the use of quartz, which is notoriously difficult to flake, attests to the stress on raw material at this location.

The majority of the cores recovered were made of silicious limestone. Discoidal cores are the most prevalent type, and there are Levallois cores and oval Levallois flakes, although this term is never defined (see Chapter 6). The scrapers consist of single, transverse, dejeté, and convergent, all with highly "stepped" retouched.

There are similarities between this assemblage and those of the Zagros sites I studied. The site is located in a montane zone and was more than likely occupied in the summer. The fine-grained lithic assemblage was heavily used and resharpened, and supplemented by local, coarser raw materials.

The small size and scarcity of these finer-grained raw materials produced very similar assemblages in both regions. At Teshik-Tash this fine-grained material was brought in from elsewhere, probably as part of the personal gear of individuals. A different situation existed with the Zagros materials, where there appear to be complete reduction sequences at all sites using the local raw material, although a similar intensive resharpening of these materials was carried out.

Discussion

The Zagros Middle Paleolithic industries are distinct from contemporary industries in the Levant because of an overall smaller size and more intensive reduction and resharpening. These conditions produced different lithic typologies in each region, but this does not translate into different populations or "cultures."

The similarities that exist between the Zagros and the Caucasus and central Asia can be explained in terms of the similarities between the comparable raw materials utilized (pebbles) and/or the same high elevation in which these sites are located. There is no reason, at this time, to discount the possibility that there could have been interaction between regions and the populations of Middle Paleolithic hominids that occupied them.

Garrod (1930) first suggested there were similarities between the Levant and Zagros Middle Paleolithic assemblages. McBurney (1964) saw marked affinities between the Zagros and Caucasus during the Paleolithic. The comparisons made in this chapter suggest that Garrod was incorrect in her assessment, whereas McBurney was correct. The differences that have been documented between the Levant and Zagros have to do with differences in raw material and site function. The similarities between the Zagros and Caucasus have to do with similarities in raw material, site function, and site location. Differences or similarities in "culture" or tradition cannot be easily monitored using lithic assemblages, but there is no reason to suspect that the hominid populations in southwest and central Asia were culturally distinct.

11

Conclusions

The Zagros Mousterian has always been viewed as an entire regional system, but our knowledge of this region and time period is probably based on what was, in reality, only one aspect of a larger settlement-subsistence strategy. It is likely that the famous "base camps" at Shanidar, Bisitun, and Barda Balka were, in fact, summer locations. It is unlikely from an environmental and climatic standpoint that these sites, which range in elevation from 740 m to above 2,000 m, could have been occupied during a Pleistocene winter. Even today the winter in this region is notoriously hard and caves are blocked with snow, making them not only uninhabitable but also, at times, invisible. During the Pleistocene, the average snow line and tree line would have been much lower, at or below the elevation of most of these sites. Therefore, it is reasonable to conclude that, when possible, the only feasible opportunity for occupation would have been during the brief summer season, and even then possibly only during very mild climatic periods, such as the interglacial documented during isotope stage 5e.

The present-day or historical land-use pattern and movement of both humans and animals in montane habitats in Southwest Asia also tend to support the suggestion of a summer-only occupation. The mobility system is consistently one of fall, winter, and spring spent in the lower elevations while summer is spent in the uplands. It is difficult to believe this pattern would have been different in the distant past for either ungulate prey species or the associated carnivore predators, including archaic hominids (Stiner 1994). Humans and animals have a long history of moving seasonally between the lowlands and the uplands in these mountainous areas of the Zagros, Levant, Caucasus, and central Asia.

Group size and site formation would have been different depending on elevation. The modern human pattern is to disperse into smaller groups in the uplands during the summer season. Sites would have been small and impermanent, although some locations such as caves, rockshelters, and springs might have been reused.

The summer occupations would have been relatively brief and, because of this, there would have been stress on the dispersed raw material necessary for the production of the tools. This would have involved the provisioning of individuals rather than of places, and raw material in the form of tools or flakes would have had to be maintained to some extent. The character of the chipped stone assemblages and what little we know of the faunal remains support this conclusion.

First, the tools in these assemblages are heavily resharpened and the cores are small and "exhausted." The analysis presented here confirms Dibble's resharpening model (1988, 1995) for the Zagros Mousterian. There is a resharpening trajectory through single, double, convergent, and dejeté scrapers. Transverse scrapers do not fit the model and appear to be unrelated, probably owing to the contrasting "squat" shape of certain blanks that promoted the production of single-edged scrapers transverse to the bulb of percussion.

Tool replacement does not occur unless the cost to manufacture a new tool blank exceeds the decreasing efficiency of maintaining a tool through resharpening. The presence of large numbers of retouched tools that are heavily resharpened, dominated by scrapers and points, is a signature of the Zagros Mousterian. Reuse and resharpening of tools is the norm. There is an investment in "formal" tools which are manufactured, used, and maintained in this summer region (and possibly beyond). In addition, there is a scarcity of large unretouched flakes at most of these sites; this suggests that they were being used up by the inhabitants faster than they were being made.

Second, larger flakes and tools were pressed into service as cores, in the form of so-called truncated/faceted pieces that yielded serviceable, albeit small, flakes, indicating there was stress on raw material. There is even indirect evidence for the transport of cores around the landscape, given the relative scarcity of these artifacts at some sites relative to the flake and tool frequencies. Conversely, some sites have only a few flakes or tools per core. This could indicate that flakes and/or tools were being manufactured at one location, carried around the landscape, and then discarded at another location. Either way, this movement of raw material around the landscape implies some planning depth and a realization by the local population of future needs for raw material. Centripetal reduction is used as an attempt to produce even more flakes from cores as demonstrated by the smaller size of these cores, which suggests they were produced late in the reduction sequence (Baumler 1988). In addition, some centripetally manufactured flakes were carried off site, while uni- and

bidirectional longitudinal flakes were produced, used, and rejuvenated at the same location. This flexible utilization of either centripetal or truncated/faceted cores depending on what types of cores or blanks were available is a key aspect of this technology during the Mousterian. The presence of centripetal cores at the end of the reduction sequence rather than as a separate core making "tradition" confirms Baumler's model.

The sites that have fewer cores with a high number of retouched tools (Kunji, Hazar Merd) suggest an emphasis on the maintenance or curation of tools rather than their manufacture, and possibly stress on raw material at these locations. Special activity sites have this type of pattern.

Other sites that contain smaller numbers of flakes and tools per core (Barda Balka fine- and coarse-grained components, Gar Arjeneh, Houmian, Kobeh, Warwasi) suggest more of an emphasis on blank and tool manufacture, and possibly a more general (residential or multipurpose) occupation.

Sites that have large numbers of flakes and tools per core (Bisitun, Kunji) are the best evidence for intensive manufacture of flakes and tools and stress on raw material. Cores could also have been carried away from these sites.

Third, the density of lithics recovered from most of these sites is lower than might be expected given what we know about lithic production and the amount of sediment excavated, intimating the length of occupation must have been relatively short and/or there was little production of new tools. The exceptions to this are Bisitun and Warwasi, but even at these locations the total count is less than 15,000 pieces. When compared with the Levant, where sites are composed of hundreds of thousands of lithics, the Zagros sites appear very different. However, while this discrepancy could be related to the extent of the excavations in each region and the amount of artifacts that were thrown away, there could also be differences in raw material size, partially processing of cores off-site, the need to conserve raw material, site function, and/or group size in the Zagros uplands.

Finally, the Minimum Number of Individuals (MNI) accounted for by the faunal remains, where available, is really quite low. Again, this could indicate poor sample size or suggest relatively short term occupations. In addition, the faunal remains are broken up as if every last bit of protein needed to be extracted (Marean and Kim 1998). Species lists are fairly diverse, as if any large ungulates that were available in this region were "collected" by hunting, scavenging, or a combination of both strategies. The contribution that large carnivores made to the faunal assemblages cannot be assessed at this time, however, due to a lack of studies about these species. Nevertheless, the presence of wolf, bear, cat, etc., remains at some of these cave sites does hint that they may have played a role in the accumulation of the faunal remains (e.g., Lindly 1988).

The lithic and faunal data suggest strategies and tactics aimed at getting the most out of an area in an expedient and opportunistic way. Tools were reused over and over again. Faunal remains were used up, as well. The hunter-gatherers living in this region during the Middle Paleolithic could best be described as foragers, moving frequently and curating "mobile toolkits." Yet, these groups used the local raw material expediently as well, by changing core reduction based on local conditions and especially elevation.

In sum, it appears that the Zagros Mousterian sites in this study were locations that small family groups of foraging archaic hominids occupied during the summer months. Group size was probably small and residential mobility high at this time of year. Mousterian groups could scavenge ungulate carcasses from the "winter kill," possibly along the melting snow line, or hunt migrating herds while they moved with them from the lowlands. Site locations were good vantage points from which to conduct intercept or ambush hunting. The animals "collected" were from the surrounding area of each site.

Cores were reduced using longitudinal flaking at first, and then the technology switched to centripetal flaking to extend the use-life of the core. If larger flakes were available, they were used as truncated/faceted cores. Tools were resharpened. Local raw material of both fine-grained and coarse-grained quality (when available) were utilized.

If these Zagros Mousterian sites were summer encampments, then the question of what was happening during the other seasons of the year in this area will have to remain an open one. Based on environmental, climatic, and ethnographic data, I suspect fall, winter, and spring sites were located in the lowlands. Although Mousterian sites have been found in the lowland areas, they have yet to be systematically analyzed. Hole and Flannery (1967:156) describe a lowland open air site at 200 m elevation near the Deh Luran plain which contains "typical" Levallois cores. The occurrence of these Levallois cores seems to be the major attribute of these lowland sites. From this evidence it appears that these sites could be quite different in their makeup from the upland counterparts and provide interesting contrasts to what we see at the upland sites.

Years ago James Skinner (1965) proposed the Zagros Mousterian as a distinct entity separate from the Levant. This study strengthens that concept by demonstrating both technologically and economically that the Zagros Mousterian is a uniform entity. However, this study also highlights the fact that we are studying only one part of a much larger whole of the Middle Paleolithic occupation of this region. Until we can return to the Zagros and examine upland *and* lowland sites from a regional perspective, we will never have a complete picture of the adaptation of Zagros Mousterian populations during the Upper Pleistocene.

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Appendix

Probability Values for Mann-Whitney U Test for Selected Tool Types by Site

Key

SS	single scraper
DS	double scraper
CV	convergent scraper
TR	transverse scraper
DJ	dejeté scraper
DEN	denticulate/notch
VEN	ventral scraper
NB	naturally backed flake
RET	miscellaneous retouched piece

c	coarse-grained raw material
f	fine-grained raw material

	Length	Width	Thickness	Platform Width	Platform Thickness	Flake Area	Platform Area	Retouch Intensity
Barda Balka f								
SS/DS	0.061	0.207	0.258	*	*	0.082	0.731	0.557
SS/CV	*	*	*	*	*	*	*	*
SS/TR	0.001	0.09	0.08	0.295	0.267	0.172	0.271	0.004
SS/DJ	*	*	*	*	*	*	*	*
SS/DEN	0.002	0.062	0.23	0.598	0.265	0.004	0.432	*
SS/VEN	0.933	0.861	0.628	0.705	0.742	0.955	0.978	*
SS/NB	0.842	0.984	0.734	0.968	0.11	0.952	0.413	*
SS/RET	*	*	*	*	*	*	*	*
DS/CV	*	*	*	*	*	*	*	*
DS/TR	*	*	*	*	*	*	*	*
DS/DJ	*	*	*	*	*	*	*	*
DS/DEN	*	*	*	*	*	*	*	*
DS/VEN	*	*	*	*	*	*	*	*
DS/NB	*	*	*	*	*	*	*	*
DS/RET	*	*	*	*	*	*	*	*
CV/TR	*	*	*	*	*	*	*	*
CV/DJ	*	*	*	*	*	*	*	*
CV/DEN	*	*	*	*	*	*	*	*
CV/VEN	*	*	*	*	*	*	*	*
TR/DJ	*	*	*	*	*	*	*	*
TR/DEN	*	*	*	*	*	*	*	*
TR/VEN	*	*	*	*	*	*	*	*
DJ/DEN	*	*	*	*	*	*	*	*
DJ/VEN	*	*	*	*	*	*	*	*
DEN/VEN	*	*	*	*	*	*	*	*

* denotes sample size too small for analysis

	Length	Width	Thickness	Platform Width	Platform Thickness	Flake Area	Platform Area	Retouch Intensity
Barda Balka c								
SS/DS	*	*	*	*	*	*	*	*
SS/CV	*	*	*	*	*	*	*	*
SS/TR	0.009	0.808	0.273	0.224	0.273	0.181	0.201	0.077
SS/DJ	*	*	*	*	*	*	*	*
SS/DEN	ns	ns	ns	ns	ns	ns	ns	ns
SS/VEN	*	*	*	*	*	*	*	*
SS/NB	0.692	0.291	0.235	0.379	0.792	0.356	0.481	*
SS/RET	*	*	*	*	*	*	*	*
DS/CV	*	*	*	*	*	*	*	*
DS/TR	*	*	*	*	*	*	*	*
DS/DJ	*	*	*	*	*	*	*	*
DS/DEN	*	*	*	*	*	*	*	*
DS/VEN	*	*	*	*	*	*	*	*
DS/NB	*	*	*	*	*	*	*	*
DS/RET	*	*	*	*	*	*	*	*
CV/TR	*	*	*	*	*	*	*	*
CV/DJ	*	*	*	*	*	*	*	*
CV/DEN	*	*	*	*	*	*	*	*
CV/VEN	*	*	*	*	*	*	*	*
TR/DJ	*	*	*	*	*	*	*	*
TR/DEN	*	*	*	*	*	*	*	*
TR/VEN	*	*	*	*	*	*	*	*
DJ/DEN	*	*	*	*	*	*	*	*
DJ/VEN	*	*	*	*	*	*	*	*
DEN/VEN	*	*	*	*	*	*	*	*

ns = not significant

	Length	Width	Thickness	Platform Width	Platform Thickness	Flake Area	Platform Area	Retouch Intensity
Bisitun								
SS/DS	0.071	0.395	0.728	ns	ns	0.715	0.599	0.722
SS/CV	0.164	0.164	0.618			0.015	0.031	0.001
SS/TR	*	*	*	*	*	*	*	*
SS/DJ	*	*	*	*	*	*	*	*
SS/DEN	*	*	*	*	*	*	*	*
SS/VEN	*	*	*	*	*	*	*	*
SS/NB	*	*	*	*	*	*	*	*
SS/RET	0.731	0.734	0.006	0.406	0.43	0.974	0.411	0.0001
DS/CV	0.008	0.011	0.052	n/a	n/a	0.008	0.011	0.006
DS/TR	*	*	*	*	*	*	*	*
DS/DJ	*	*	*	*	*	*	*	*
DS/DEN	*	*	*	*	*	*	*	*
DS/VEN	*	*	*	*	*	*	*	*
DS/NB	*	*	*	*	*	*	*	*
DS/RET	*	*	*	*	*	*	*	*
CV/TR	*	*	*	*	*	*	*	*
CV/DJ	*	*	*	*	*	*	*	*
CV/DEN	*	*	*	*	*	*	*	*
CV/VEN	*	*	*	*	*	*	*	*
TR/DJ	*	*	*	*	*	*	*	*
TR/DEN	*	*	*	*	*	*	*	*
TR/VEN	*	*	*	*	*	*	*	*
DJ/DEN	*	*	*	*	*	*	*	*
DJ/VEN	*	*	*	*	*	*	*	*
DEN/VEN	*	*	*	*	*	*	*	*

n/a = data not available

	Length	Width	Thickness	Platform Width	Platform Thickness	Flake Area	Platform Area	Retouch Intensity
Gar Arjeneh								
SS/DS	0.205	0.792	0.909	ns	ns	0.193	0.995	0.993
SS/CV	0.036	0.561	0.897	ns	ns	0.185	0.742	0.011
SS/TR	0.0001	0.062	0.078	0.633	0.25	0.197	0.702	0.073
SS/DJ	0.074	0.153	0.978	0.16	0.529	0.753	0.719	0.023
SS/DEN	*	*	*	*	*	*	*	*
SS/VEN	*	*	*	*	*	*	*	*
SS/NB	*	*	*	*	*	*	*	*
SS/RET	0.052	0.061	0.003	0.784	0.394	0.028	0.679	0.605
DS/CV	0.73	0.234	0.686	ns	ns	0.392	0.887	0.3
DS/TR	0.0001	0.271	0.333	0.616	0.333	0.057	0.867	0.284
DS/DJ	0.044	0.614	0.661	0.254	0.93	0.254	0.792	0.16
DS/DEN	*	*	*	*	*	*	*	*
DS/VEN	*	*	*	*	*	*	*	*
DS/NB	*	*	*	*	*	*	*	*
DS/RET	*	*	*	*	*	*	*	*
CV/TR	0.001	0.63	0.102	0.248	0.149	0.034	0.102	0.53
CV/DJ	0.029	0.044	0.879	0.275	0.499	1	0.334	0.619
CV/DEN	*	*	*	*	*	*	*	*
CV/VEN	*	*	*	*	*	*	*	*
TR/DJ	0.006	0.462	0.101	0.843	0.234	0.258	0.651	0.865
TR/DEN	*	*	*	*	*	*	*	*
TR/VEN	*	*	*	*	*	*	*	*
DJ/DEN	*	*	*	*	*	*	*	*
DJ/VEN	*	*	*	*	*	*	*	*
DEN/VEN	*	*	*	*	*	*	*	*

	Length	Width	Thickness	Platform Width	Platform Thickness	Flake Area	Platform Area	Retouch Intensity
Kobeh								
SS/DS	0.126	0.001	0.422	n/a	n/a	0.061	0.003	0.164
SS/CV	0.045	0.001	0.249	n/a	n/a	0.01	0.158	
SS/TR	0.001	0.001	0.03	0.001	0.057	0.617	0.001	0.106
SS/DJ	0.009	0.857	0.362	0.057	0.331	0.067	0.156	0.005
SS/DEN	0.089	0.97	0.652	0.672	0.732	0.245	0.7	*
SS/VEN	*	*	*	*	*	*	*	*
SS/NB	*	*	*	*	*	*	*	*
SS/RET	0.11	0.766	0.001	0.78	0.229	0.262	0.402	0.001
DS/CV	0.582	0.272	0.101	*	*	0.384		0.275
DS/TR	0.001	0.001	0.007	0.001	0.002	0.28	0.001	0.505
DS/DJ	0.001	0.021	0.181	0.001	0.02	0.229	0.002	0.147
DS/DEN	0.001	0.021	0.34	0.01	0.07	0.88	0.009	*
DS/VEN	*	*	*	*	*	*	*	*
DS/NB	*	*	*	*	*	*	*	*
DS/RET	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
CV/TR	0.001	0.001	0.061	0.001	0.009	0.112	0.001	0.696
CV/DJ	0.001	0.002	0.578	0.001	0.072	0.459	0.006	0.234
CV/DEN	0.002	0.001	0.984	0.018	0.124	0.59	0.039	*
CV/VEN	*	*	*	*	*	*	*	*
TR/DJ	0.028	0.001	0.193	0.007	0.376	0.193	0.019	0.627
TR/DEN	0.001	0.0001	0.095	0.001	0.162	0.271	0.003	*
TR/VEN	*	*	*	*	*	*	*	*
DJ/DEN	0.259	0.858	0.591	0.297	0.555	0.317	0.307	*
DJ/VEN	*	*	*	*	*	*	*	*
DEN/VEN	*	*	*	*	*	*	*	*

	Length	Width	Thickness	Platform Width	Platform Thickness	Flake Area	Platform Area	Retouch Intensity
Kunji								
SS/DS	0.494	0.488	0.868	n/a	n/a	0.526	0.426	0.611
SS/CV	0.884	0.002	0.352	n/a	n/a	0.083	0.288	0.001
SS/TR	0.001	0.045	0.743	0.08	0.729	0.074	0.203	0.93
SS/DJ	0.001	0.442	0.704	0.931	0.512	0.035	0.802	0.789
SS/DEN	*	*	*	*	*	*	*	*
SS/VEN	*	*	*	*	*	*	*	*
SS/NB	*	*	*	*	*	*	*	*
SS/RET	*	*	*	*	*	*	*	*
DS/CV	0.894	0.05	0.425	n/a	n/a	0.132	0.929	0.61
DS/TR	0.001	0.081	0.824	0.061	0.68	0.427	0.215	0.679
DS/DJ	0.068	0.953	0.606	0.302	0.525	0.142	0.341	0.676
DS/DEN	*	*	*	*	*	*	*	*
DS/VEN	*	*	*	*	*	*	*	*
DS/NB	*	*	*	*	*	*	*	*
DS/RET	*	*	*	*	*	*	*	*
CV/TR	0.01	0.01	0.315	0.125	0.153	0.491	0.101	0.596
CV/DJ	0.529	0.038	0.068	0.231	0.147	0.801	0.131	0.507
CV/DEN	*	*	*	*	*	*	*	*
CV/VEN	*	*	*	*	*	*	*	*
TR/DJ	0.01	0.03	0.765	0.086	0.941	0.765	0.456	0.737
TR/DEN	*	*	*	*	*	*	*	*
TR/VEN	*	*	*	*	*	*	*	*
DJ/DEN	*	*	*	*	*	*	*	*
DJ/VEN	*	*	*	*	*	*	*	*
DEN/VEN	*	*	*	*	*	*	*	*

	Length	Width	Thickness	Platform Width	Platform Thickness	Flake Area	Platform Area	Retouch Intensity
Shanidar								
SS/DS	0.242	0.03	1	n/a	n/a	0.097	0.44	0.222
SS/CV	0.242	0.025	0.241	n/a	n/a	0.04	0.435	0.249
SS/TR	*	*	*	*	*	*	*	*
SS/DJ	*	*	*	*	*	*	*	*
SS/DEN	0.943	0.722	0.619	0.831	0.887	0.477	1	*
SS/VEN	*	*	*	*	*	*	*	*
SS/NB	*	*	*	*	*	*	*	*
SS/RET	0.05	0.554	0.205	0.554	0.31	0.04	0.272	0.108
DS/CV	0.897	0.3	0.245	n/a	n/a	0.796	0.137	0.79
DS/TR	*	*	*	*	*	*	*	*
DS/DJ	*	*	*	*	*	*	*	*
DS/DEN	*	*	*	*	*	*	*	*
DS/VEN	*	*	*	*	*	*	*	*
DS/NB	*	*	*	*	*	*	*	*
DS/RET	*	*	*	*	*	*	*	*
CV/TR	*	*	*	*	*	*	*	*
CV/DJ	*	*	*	*	*	*	*	*
CV/DEN	0.732	0.16	0.305	0.676	0.909	0.239	0.909	*
CV/VEN	*	*	*	*	*	*	*	*
TR/DJ	*	*	*	*	*	*	*	*
TR/DEN	*	*	*	*	*	*	*	*
TR/VEN	*	*	*	*	*	*	*	*
DJ/DEN	*	*	*	*	*	*	*	*
DJ/VEN	*	*	*	*	*	*	*	*
DEN/VEN	*	*	*	*	*	*	*	*

	Length	Width	Thickness	Platform Width	Platform Thickness	Flake Area	Platform Area	Retouch Intensity
Warwasi F								
SS/DS	0.808	0.424	0.548	n/a	n/a	0.754	0.014	0.365
SS/CV	0.103	0.69	0.185	n/a	n/a	0.648	0.002	0.229
SS/TR	*	*	*	*	*	*	*	*
SS/DJ	*	*	*	*	*	*	*	*
SS/DEN	0.003	0.027	0.284	0.059	0.045	0.002	0.04	8
SS/VEN	*	*	*	*	*	*	*	*
SS/NB	0.01	0.001	0.043	0.002	0.003	0.001	0.001	*
SS/RET	0.258	0.149	0.005	0.938	0.713	0.113	0.646	0.001
DS/CV	0.331	0.589	0.13	n/a	n/a	0.494	0.001	0.339
DS/TR	*	*	*	*	*	*	*	*
DS/DJ	*	*	*	*	*	*	*	*
DS/DEN	0.01	0.431	0.838	0.854	0.531	0.04	0.597	*
DS/VEN	*	*	*	*	*	*	*	*
DS/NB	0.02	0.003	0.184	0.297	0.464	0.001	0.297	*
DS/RET	*	*	*	*	*	*	*	*
CV/TR	*	*	*	*	*	*	*	*
CV/DJ	*	*	*	*	*	*	*	*
CV/DEN	0.001	0.217	0.05	0.001	0.001	0.01	0.001	*
CV/VEN	*	*	*	*	*	*	*	*
CV/NB	0.002	0.002	0.011	0.001	0.001	0.001	0.001	
TR/DJ	*	*	*	*	*	*	*	*
TR/DEN	*	*	*	*	*	*	*	*
TR/VEN	*	*	*	*	*	*	*	*
DJ/DEN	*	*	*	*	*	*	*	*
DJ/VEN	*	*	*	*	*	*	*	*
DEN/VEN	*	*	*	*	*	*	*	*
NB/DEN	0.957	0.011	0.267	0.143	0.133	0.045	0.11	*

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